Radio, Electronics and Communications

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In This Issue . . .

- Compact Broad-Band Balun Transformers
- Electronics in Medicine
- The D.D.R.R. Antenna
- Mobile Communications — Part II
- Electrical Units Derived from Fundamental Standards
- Listening Post, Satellite News

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 20 NUMBER 3

MAY 1, 1965

PRICE 2/6

AWA Releases First Australian 25" Tv. Receiver

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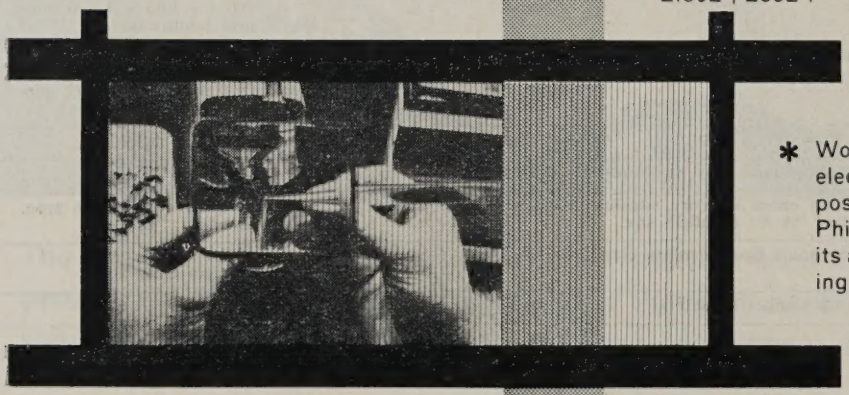

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E186F(7737)	3	190	13	53	16.5
E810F(7788)	5	135	35	57	50
E130L(7534)	27.5	250	100	65	25
E55L	10	140	50	30	45

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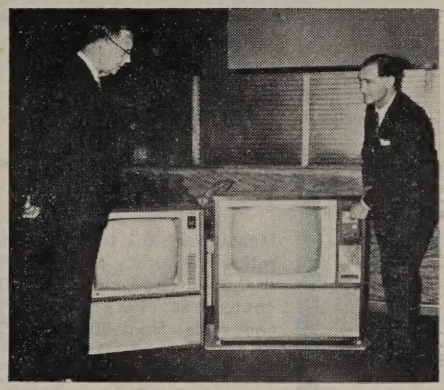

Left to right: Mr. C. H. Wainwright, General Manager of Chandlers, Brisbane, standing alongside the old 23" receiver, and John Bailey, AWA General Sales Manager, switching on the new 25"

AWA Releases First Australian 25" Tv. Receiver

AWA's leadership was again demonstrated by the release in Australia of the 25 inch "Wide Screen" TV receiver. The picture tube (Super Radiotron 25LP4) was manufactured in Australia by Amalgamated Wireless Valve Co. Pty. Limited.

Since the release of the first model, AWA has announced a complete family of 25" sets which have met with overwhelming acceptance from retailers and the public. The 25" tube provides the proper 4:3 aspect ratio which enables the full transmitted picture to be reproduced on the screen.

At a recent convention in Melbourne, Victoria retailers paid tribute to AWA and AWV for pioneering the introduction of Wide Screen Television in Australia. The new AWA 11" portable was unveiled at the same time and was praised for its beauty and performance.

ENQUIRY CARD AD. 4

COMING . . .

Atomic Frequency Standard
The Manufacture of Telephone Cable
Medical Electronics—*continued*
A Slave Unit
VLF Propagation Series
Beam Switching Amplifier
Mobile Communications Series—*continued*

Also . . .

Circuit & Service Data
Book Reviews
Serviceman's Column
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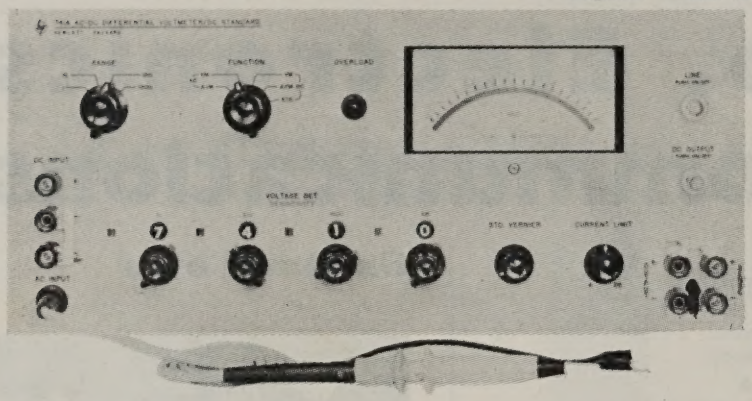
New Products

ENQUIRY CARD AD. 5



the new hp 741A

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Measure 0 to 1000 v in 7 ranges with an accuracy of 0.02% ±10 μv, and input impedance greater than 10^9 ohms on all ranges, independent of null. Here's totally unique performance to be compared with conventional dc differential voltmeters, whose input impedance is low except at null. Thus, the 741A is ideal for drift measurements, with accuracy independent of null conditions. Stability is 0.003%/8 hours and 0.005%/month.

DC STANDARD

The 741A delivers accurate dc voltages from 0 to 1000 volts at currents up to 20 ma. Front-panel current limit control is useful for protecting external circuits from damage. Floating output allows either positive or negative ground with remote sensing. Accuracy is 0.02% of the indicated setting and stability is the same as that of the dc differential voltmeter. Voltage setting is indicated by 4 digits, with the remainder of the reading shown on the front-panel meter. Output resolution is 1 ppm on any range, directly readable on the front panel.

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With ranges from 1 mv to 1000 volts, the 741A is a ±2% floating dc voltmeter with input impedance greater than 10^8 ohms on all ranges. It also is a ±2% floating ac voltmeter from 1 mv to 1000 volts, with the low capacity probe providing a 1 megohm input impedance (< 5 pf shunt) on all ranges.

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The reference supply in the 741A consists of a temperature-controlled zener diode and maintains the high stability specified. This supply can be compared with a standard cell and measured differentially with the 741A without disassembling the instrument.

All this—and the 741A is priced at only $1475!

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Letters from Readers

Sir,

In the June 1964 edition of Radio, Electronics and Communications was printed a circuit of a two metre receiver. Could you please explain the following:

(a) The gauge of the wire used to wire the I.F. coils
(b) The values of the capacitances shown in the R.F. stage as CN variable and Cn fixed.

J. W. WELSH,
Masterton.

Thank you for your letter. In answer to your queries— (1) The I.F. transformers as shown on P. 30 of the June 1964 issue are wound with 36 G. wire. The number of turns required is 55, not 35 as shown on the drawing for which we apologise but have only just noticed the error. The winding should occupy almost 1.25 cms or ½ inch with a spacing between windings of approximately 1.5 cms. or 6/10th of an inch. (2) The two capacitances for neutralisation are CN (variable) 3-30 pf. trimmer. Cn (fixed) 5 pf.

—Ed.

Sir,

I am just completing a quantity of high powered amplifier units for a local dance band, and to give it a "professional" look require a quantity (6) of labelled panels to a design that would be supplied. I have no knowledge of any manufacturer who does this type of work, and I ask for your assistance. The boys are willing to pay for exclusive equipment.

Incidentally now, I think R. E. & C's tendency to a more technical nature is fine, but I do think a regular section on audio would be appreciated.

D. W. CLARK,
Te Aroha.

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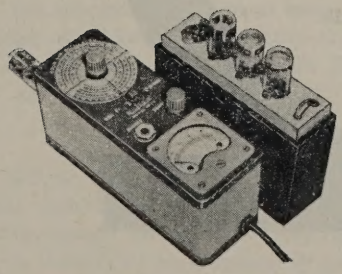

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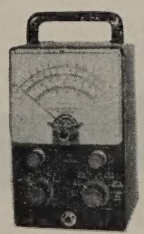

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ENQUIRY CARD AD. 8

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		100pA — 10 μA d.c.	3%	100 MΩ//15-10 pF (2)	recorder output
GM 6012 L.F.	2 c/s — 1 Mc/s	1 mV — 300 V a.c.	2.5/5%	4-10 MΩ//20-10 pF	amplifier output
GM 6025 V.H.F.	0.1 Mc/s — 800 Mc/s	10 mV — 10 V a.c.	5%/15%	35-65 kΩ//1 pF	calibration voltage for each measuring range
PM 2405 volt-ohm	20 c/s — 1000 Mc/s	500 mV — 300 V a.c.	2.5%	3.5 pF	automatic range selection;
		500 mV — 500 V d.c.	2.5%	10 MΩ//2 pF	automatic polarity indication
		10Ω — 100 MΩ	4%/5%		
PM 2453 a.c.	10 c/s — 5 Mc/s	1 mV — 300 V	5%/9%	1MΩ//15-35 pF	fully transistorised; battery-operated

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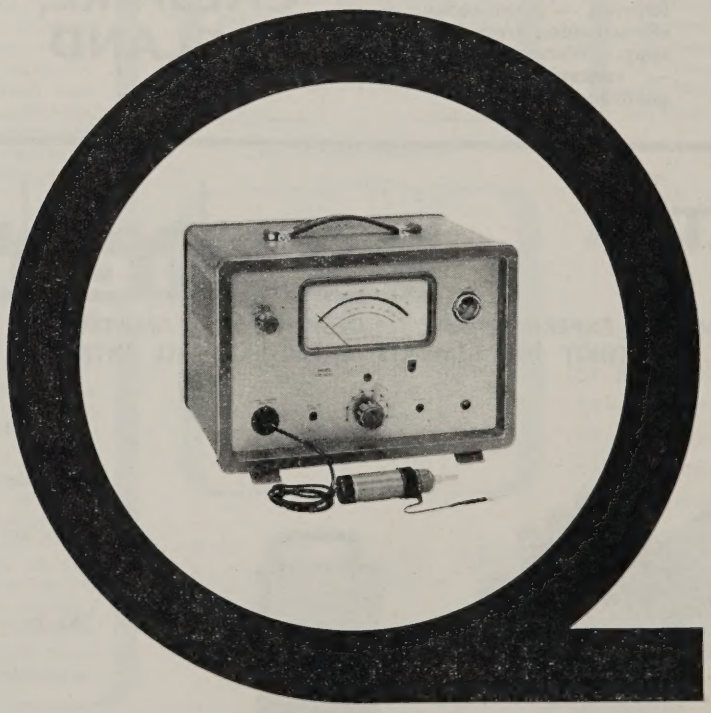

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Hams: Time for Stocktaking

Scanning through the numerous overseas journals devoted to amateur radio which pass the Editor's desk, it is evident that there is one matter which is vital to all amateurs. It is being discussed, expounded and often vigorously debated — the need for the world's amateurs to show the remainder of the world at large that they are worthy of consideration at future international conventions set up to allocate radio-frequency spectrum space. Let us consider some of the aspects as they affect this country.

The amateur licence is described in the Radio Regulations 1953 which state, "Amateur station licences shall authorise the establishment of stations for operation in the amateur service — that is to say, a service of inter-communication and technical investigation carried on by duly authorised persons interested in radio techniques solely with a personal aim and without pecuniary interest."

Nowadays, the stress is being placed on the words "technical investigation." Whilst contacts between amateurs do much to aid friendly relations between various countries and produce trained operators who are available to the country in times of civil or national emergency, the administrators of radio services in many countries are wondering how they can continue to substantiate the amateur service on these grounds alone.

It has also become obvious that with the vast amount of commercially constructed equipment finding its way onto amateur operating tables (yes — even in this country), a new — and very degrading — term for one section of the amateur community has arisen; "the appliance operator". It has been suggested — we hope without substantiation — that some of these "appliance operators" could not service their equipment if it failed, even with the aid of an instruction manual. It is certain that this type of amateur is of little value to the amateur fraternity, or to the country as a whole.

Let us then look at this propect of "technical investigations". When this topic has been raised before, some have said, "What can the amateur do of value by comparison with the efforts of large commercial and non-commercial research organisations?"

The amateur can, and does, succeed in many ways. One reason for this is that there are many amateurs, spread all over the globe, and thus many simultaneous observations can be made at one time on matters of geographical or geophysical value. But amateurs also can be of value in their small workshops, if they are prepared to do so. For example, the development of very stable variable frequency oscillator systems; slow scan television; the problem of overloading and cross-modulation effects in receivers, particularly those using semiconductors; the development of television interference suppression techniques — have all been largely advanced by amateurs.

What research projects can one carry out in this country? Interested in Propagation? Then you could be studying signals from the many satellites passing overhead or from Syncom 3 stationary over the Pacific. Interested in Mobile operation? Then some work on transistorised frequency synthesisers, or noise suppression, or semiconductor transmitters, or more efficient antenna systems could be your line of interest. Interested in 80 metres or 20 metres? Did you arrange some tests with stations in the Pacific during the period of the Solar Eclipse? Interested in V.H.F.? Then have you considered Polarisation diversity receiving systems, or moon reflection tests? Interested in S.S.B.? Then Phase locked local oscillator systems or improvements in linear amplifiers might provide some interest. And so the list could go on for pages.

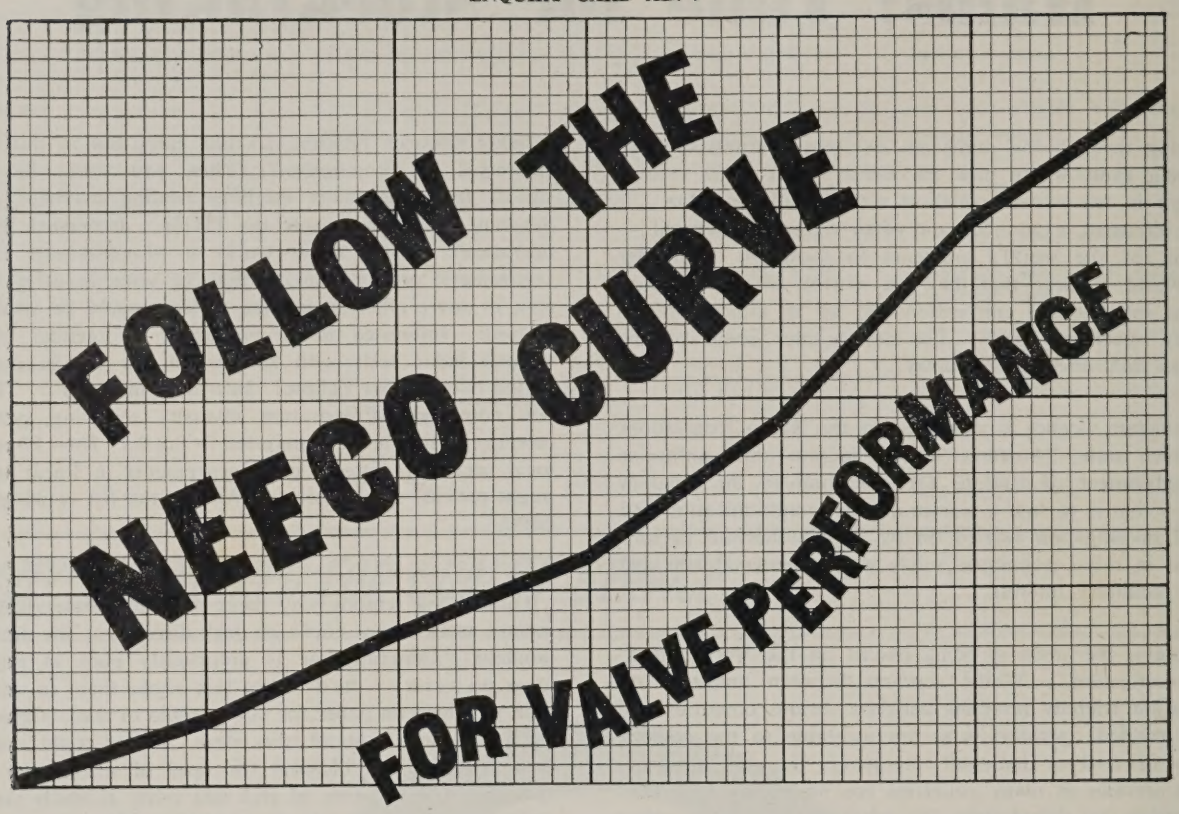
One of the reasons why there is so little integrated experimental work done, could be laid directly at the feet of the amateur. Generally, he is notoriously poor in putting his ideas on paper — he'd rather talk about them to one person than put them on paper for 1000 people to read. Consequently many, if not most of the ideas, which could collectively bear fruit, fail to blossom for need of a common meeting ground. The columns of this and other journals are always open for such technical notes and discussions.

Another avenue worth pursuing, backed by considerable overseas precedent, could be the use of the N.Z.A.R.T's. annual conference. Over the past few years the various conference committees have seen fit to include some form of technical forum in the framework of the conference weekend. These technical discussions have fitted in with other activities and generally only lasted an hour or so. Would it not be possible to expand the technical side of conference so that it occupied at least a full day, with a number of major and minor technical lectures being presented, with time for discussion as well?

Other sections of amateurs' interests would need to be catered for, of course. For example, mobile rallies, discussions of various contests, displays of A.R.E.C. operations and procedures, whilst some of the other groups would also need time for their affairs. To fit all this into a weekend is not possible under the existing system. Once again a suggestion; could not the association's council of elected representatives deal with most of the matters of branch remits, aided by the results of the voting of each branch? This would mean that official conference business could be limited to half a day, and the remaining time spent on matters nearer and dearer to the heart of the average amateur. He would probably leave at the conclusion of the weekend with renewed interest, fresh ideas, and the feeling that he had learnt something new — in short with the feeling that his time had been well spent.

— I. H. S.

ENQUIRY CARD AD. 9



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V2.1

ELECTRICAL UNITS DERIVED FROM FUNDAMENTAL STANDARDS

By R. D. KUYKENDALL and R. M. PAILTHORP *

Introduction

Suppose that the electrical units were not planned, but just grew. (The supposition may not be far from the truth). Suppose that each time a new unit was needed, it was selected in an arbitrary manner. The standard volt might be, for instance, the open-circuit voltage of a specified cell, the ampere might be the short-circuit current of a specific generator turned at a specified speed, and the ohm might be the resistance of a specified piece of wire at a specific temperature. One might easily think of other units for capacitance, inductance, etc.

Constants of Proportionality

The first thing one might notice would be that the electrical laws would all have constants of proportionality. Some examples of these laws are shown below.

$$E = k_1 IR \qquad E_L = k_2 L \frac{dI_L}{dt}$$

$$P = k_2 IE \qquad I_C = k_4 C \frac{dE_C}{dt}$$

$$P = k_3 k_2 I^2 R \qquad f_1 = \frac{1}{2\pi \sqrt{k_3 k_4 LC}}$$

$$P = \frac{k_2}{k_1} \frac{E^2}{R}$$

It is much more convenient to define the units in such a way that most of the constants are made equal to one. It is not possible to make them all equal one; for example, the constant 2π in the formula for resonant frequency is there because the formula has to do with sine functions, and would remain in the formula regardless of the values of k_3 and k_4.

Choice of Fundamental Quantities

Note that there are four basically different formulae (hence four constants) and seven quantities: voltage, current, resistance, power, inductance, capacitance, and time (or frequency). If these were the only formulae necessary in electricity, we could establish three of these quantities as fundamental and define the rest of them in terms of the three fundamentals.

* Electro Scientific Industries Inc., Oregon
Represented by Sample Electronics (N.Z.) Ltd.

We could, for instance, choose arbitrary units of voltage, current and capacitance. Then, by setting all constants, k_N, equal to one, resistance, power and time are derived from the fundamentals and inductance could be derived from two fundamental units, voltage and current, and from one derived unit, time. If time is a derived quantity, we would have an awkward conversion factor when we tried to compare electrical time with the time that everyone else uses.

There are other quantities that would present awkward conversion factors if the fundamental units were not chosen with some care.. Consider power and energy as an example. The chain of formulae that leads from the fundamental units of the mks (meter-kilogram-second) system to the definition of mechanical power is shown in Figure 1 and Table I.

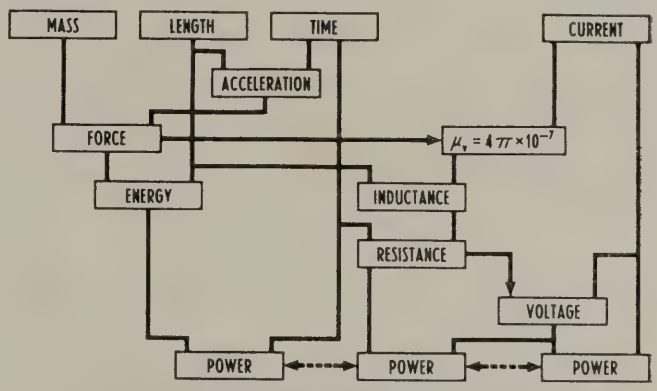


FIGURE 1. A DERIVATION OF POWER

QUANTITY	ABBREVIATION	FORMULA	NAME	SYMBOLIC UNITS
LENGTH	l	(FUNDAMENTAL)	METER (m)	m
MASS	M	(FUNDAMENTAL)	KILOGRAM (kg)	kg
TIME	T	(FUNDAMENTAL)	SECOND (s)	s
ACCELERATION	a	$a = \frac{d^2 l}{dT^2}$	—	$\frac{m}{s^2}$
FORCE	F	$F = Ma$	NEWTON (n)	$\frac{m\,kg}{s^2}$
ENERGY	w	$w = \int F dl$	JOULE (j)	$\frac{m^2 kg}{s^2}$
POWER	P	$P = \frac{dw}{dT}$	WATT (w)	$\frac{m^2 kg}{s^3}$

TABLE I. EXAMPLES OF QUANTITIES DERIVED FROM FUNDAMENTALS

Consistent System

Since power and energy can be derived both from the fundamental mechanical units of the mks system and from the electrical units, it would be well if both electrical and mechanical power and energy were measured in the same units. A system in which the same quantity always has the same units is called a consistent system. One might enforce this consistency by defining the watt as one of the fundamental units, but the present state of the art is such that power cannot be measured mechanically with satisfactory accuracy. For this

reason the watt is not established as a fundamental. But we should stipulate that whatever system is used, units of power and energy must be consistent between mechanical and electrical systems.

MKSA System

The difficulties of having an inconsistent system have been overcome in the MKSA (metre-kilogram-second-ampere) system of units, the system that has been adopted for most scientific work. This is accomplished by defining time to be fundamental in both electrical and mechanical measurements, and by defining the fundamental unit of current, the ampere, in a way which makes it possible to derive the electrical units from the fundamental mechanical units of length, time, and mass. In order to show how this is done, we introduce two more equations:

$$\text{Ampere's Equation: } \mathbf{F} = \frac{\mu_V \mathbf{I}^2 \mathbf{l}}{2\pi \mathbf{S}}$$

gives the force, F, between two long straight conductors of length l, placed a distance, S, apart in a vacuum when each conductor is carrying a current I. The symbol μ_V denotes the permeability of free space.

The other formula that we introduce:

$$\mathbf{L} = \mu_V \mathbf{N}^2 \pi \mathbf{r}^2 \mathbf{l}$$

gives the inductance, L, of a long solenoid of length l, and radius r, with N turns per unit length, when it is in a vacuum.

Note that the permeability of free space is in both formulas and that the formula for inductance is in terms of permeability and length. If one quantity, permeability, inductance, or current is defined to be fundamental, the other two quantities can be derived from fundamentals, and all the other electrical quantities, such as voltage, capacitance, and resistance, can be derived from inductance, time, and current.

Definition of the Ampere

The International Conference on Weights and Measures defined the Ampere in terms of Ampere's equation.

> "The ampere is the constant current which, if maintained between two straight parallel conductors of infinite length, of negligible circular sections, and placed 1 meter apart in a vacuum, will produce between these conductors a force equal to 2×10^{-7} mks units of force per meter of length."

The definition is in terms of force and length, but it implies an assumption that the permeability of free space, μ_V, is equal to $4\pi \times 10^{-7}$, and has caused a certain amount of confusion as to whether the ampere is fundamental or the permeability of free space is fundamental. There seems to be no overwhelming reason for calling one of them fundamental rather than the other as long as the two are properly interrelated.

There is at least one historical precedent for defining a unit in terms of a physical constant. When the metric system was first developed, the unit of mass, the gram, was defined to be the mass of a cubic centimetre of water. This definition simplifies the determination of density because it sets density equal to specific gravity. Implied in the definition is the assumption that the density of water is equal to one. One might say that the definition is actually a characteristic of water, its density. The definition of the fundamental unit of current, the ampere, is reminiscent of this definition of mass.

Definition of the Kilogram

There is another parallel between the definitions of mass and current. An early definition of the ampere was: the current required to deposit a specified quantity of silver from an aqueous silver nitrate solution in one second. This definition of current was dropped because it was not possible to duplicate the experiment with sufficient accuracy. The original metric system definition of mass was dropped because of the difficulties of producing exactly a given volume of water. The kilogram is the fundamental unit of mass in the MKSA system, and is presently defined as the mass of a specific cylinder of metal.

Definition of the Meter

The other units of the MKSA system have had similar changes of definition since the beginning of the metric system. The metre was once defined as one ten-millionth of the distance from the equator of the earth to the pole. This distance could not be measured accurately enough, so the definition was changed to be the distance between two scratches on a specific platinum-iridium bar at 0°C. That definition was sufficient for more than a century and a half but recently the definition has been changed again because the phenomenon of interference fringes is more easily and accurately reproducible. The metre is now defined as 1,650,763.73 wavelengths of orange-red light emitted by ionized krypton-86 operating at the triple point of nitrogen.

Definition of the Second

The second was originally defined as 1/86,400 of a day. Unfortunately, time as measured by the rotation of the earth is not even as consistent as a good pendulum clock. The excursion of the earth around the sun is more consistent, but even this has measurable variations. The definition of the second has been amended several times in order to keep up with the state of the art of time measurement. At the present, the second is defined as: 1/31,556,925.9747 of the tropical year at 12^h ephemeris time, 0 January, 1900.

At the present, elapsed time is being measured, and the second is being maintained, by measurement of the resonant frequency at the ground state of the cesium atom. On occasion, this time is changed to agree with the results of astronomical observations. These observations relate the unit of time to its definition.

No matter how convenient the definitions of the fundamental units are, it is of no use to define them if they cannot be reproduced. As we have

seen, a convenient definition of the unit of mass based on a characteristic of water was discarded because of problems in accurate volume measurement. A convenient definition of the metre in terms of the earth's circumference was dropped because of problems of accurate measurement of the earth's circumference. The definition of the ampere in terms of electroplating a specified mass in a specified time was dropped because of problems in repeating the experiment.

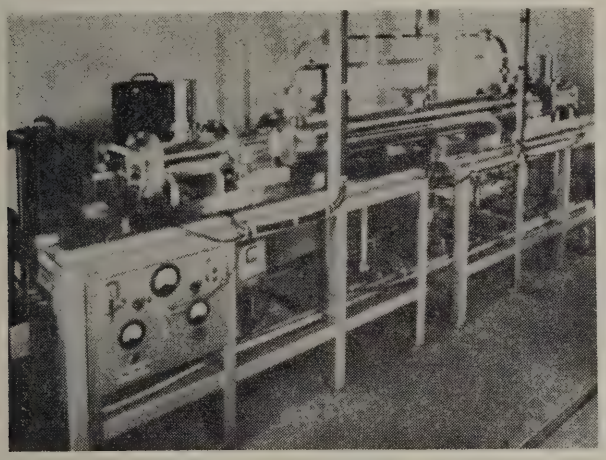


FIGURE 2. CESIUM BEAM FREQUENCY STANDARD
(Photograph courtesy NBS)

Determining the Ampere

At first glance, one might think that the definition of the ampere would be impossible to follow exactly. It specifies two straight parallel conductors of infinite length in a vacuum. It would seem that this would require an infinitely long straight laboratory in which to perform the experiment. The definition of the ampere was made for mathematical, not experimental, convenience. However, it is possible to construct apparatus for which the current can be calculated as a function of force. An apparatus used by the National Bureau of Standards to produce a current that is known in terms of length and force is the NBS Current Balance.

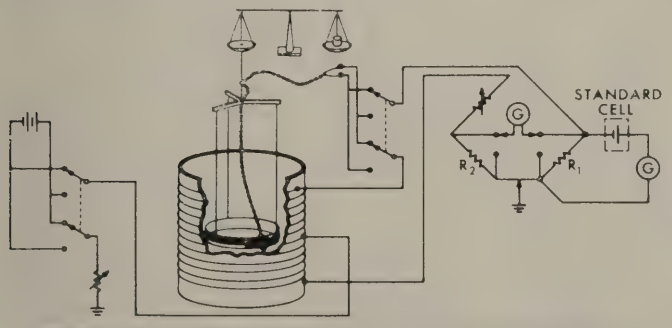


FIGURE 3. SCHEMATIC OF THE NBS CURRENT BALANCE

The current passing through the coils in the outer solenoid tends to move the centre coil either up or down depending on the direction of current flow. The current is adjusted so that the force on the coil is balanced by weights on the pans of the scale, then the current in one coil is reversed and the scale is rebalanced by adding or removing a weight. The difference between the forces produced with the current flowing in each direction is proportional to the square of the current times a function of the mechanical dimension of the coils. The current passes through a standard resistor, R_1 and the voltage drop is compared with that of a standard cell.

This experiment produces a known current, but when the experiment is over, the current is gone. The standard cell and the standard resistor are used in this experiment as a means of remembering what the current was.

The mathematics of computing the actual current are cumbersome and the procedure is time-consuming. For example, the function of the mechanical dimensions of coils requires exhaustive measurement of the length of the wires in each turn. The force produced by the coils is measured by balancing weights, and thus the force must be computed from the mass of the weights and the acceleration of gravity. It is necessary for the accuracy of the experiment to determine the exact acceleration of gravity, which, by the way, varies with the tides. The Bureau of Standards' estimation of the accuracy of the derivation of current is shown in Table II.

SOURCES OF ERROR	e (50% ERROR)
MEASUREMENT OF THE FORCE	2 ppm
LEAD CORRECTIONS	2
RADIUS OF FIXED COIL	2
RADIUS OF MOVABLE COIL	3
CURRENT DISTRIBUTION OVER WIRES	1
CALIBRATION OF LENGTH STANDARDS	1
CALIBRATION OF STANDARD MASS	1
CALIBRATION OF ELECTRICAL STANDARDS	1
ADJUSTMENT OF COILS	1
TEMPERATURE OF COILS	1
PERMEABILITY OF FORMS	<1
ACCELERATION OF GRAVITY	3
50% ERROR IN FINAL RESULT, $\sqrt{\Sigma e^2}$	6

TABLE II. SOURCES OF ERROR CAUSING AN UNCERTAINTY, e, IN RATIO 1abc/1NBS AS LARGE AS 1 ppm

Derivation of the Volt

It might be noted at this point that the standard cell and standard resistor used in the current derivation experiment do not need to have any particular accuracy. The experiment determines their ratio $\left(I = \frac{E}{R}\right)$ and gives no indication of their values or accuracy. Once this ratio is known, derivation of the ohm will also yield the value of the volt.

The Ohm and Inductance

The original definition of the ohm was the resistance of a column of mercury of a specific length and diameter. This definition was not sufficiently reproducible and is not conducive to a consistent system. However, the definition of current as given

Continued on page 28

THE "D.D.R.R." ANTENNA

This article attempts to summarise some of the technical and constructional details of a unique approach to a dimensionally compact antenna system, which can be designed and constructed to operate at frequencies from 2 to 150 megacycles. Capable of being capacitively tuned over a frequency range of 2:1 and satisfactorily matched to standard coaxial feedlines, the "Directional Discontinuity Ring Radiator" was developed, produced and patented by J. M. Boyer (holder of the amateur call sign W6UYH), chief of the Radio-Physics research group at Northrop's Ventura Division.

The "D.D.R.R." is a highly efficient omni-directional vertically-polarised radiator which offers a considerable height reduction over that of a full quarter wavelength vertical antenna, compared with which it performs very favourably.

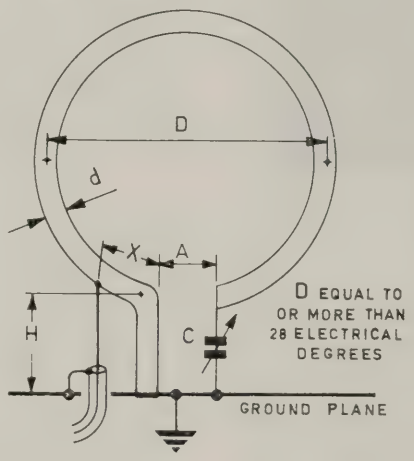
A naturally resonant, vertical, antenna such as the grounded quarter wavelength radiator is a colinear aperture. Its properties are ideal for general communications, providing an omni-directional radiation pattern with most energy radiated at low angles to the horizon.

At its full height, the radiation resistance of the quarter wave vertical is far greater than any normal electrical loss resistance in the conductors. Even when operated over soil, the vertical's characteristics permit excellent radiation efficiency even with simple wire radial ground plane networks.

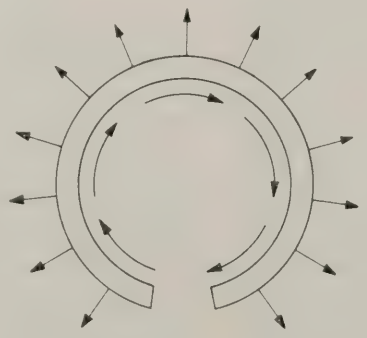
When the height of this classical antenna is markedly reduced and electrical resonance restored by the introduction of lumped inductance and or capacitance, performance deteriorates severely. The reason is that the reduction of physical height removes a portion of the colinear aperture of the vertical antenna. Loss of colinear aperture means loss of radiation resistance, resulting in less of the applied power being coupled out to space.

THE D.D.R.R. ANTENNA

'A' GENERAL CONFIGURATION SHOWING CRITICAL DIMENSIONS, METHOD OF FEED, TUNING ETC.



'B' THE CURRENT IN THE RING ELEMENT



In the case of the "D.D.R.R." antenna, circumferential aperture is substituted for the colinear portion lost by the reduction of height. Consider now a circular array (See Fig. 1) consisting of a single conductor mounted in a horizontal plane a short distance above an electrical ground plane.

The best performance from this type of antenna can be determined to occur when the circumference of the array is one quarter wavelength, and therefore naturally resonant. This gives an antenna with a diameter D of 0.078 of a wavelength (28 electrical degrees). The ring is mounted on insulators at a distance of approximately 0.007 of a wavelength (2.5 electrical degrees) above a ground plane, connected to it at one end through a short vertical element. The other end is spaced away from the vertical section a short distance "A".

In practice, for precise adjustment, or where operation is desired at more than one frequency, the diameter of the ring is made slightly less than stated above, thus reducing the circumference slightly and a variable condenser is connected from the free end of the ring to the ground plane. Energy is coupled out of and into the antenna by a shunt fed coaxial line. The outer conductor of this is connected to the ground plane whilst the inner conductor is connected to an appropriate tap on the ring to provide the correct impedance match.

The best performance and lowest angle of radiation is obtained when the ground plane is extended beyond the boundaries of the ring. This can be fairly satisfactorily accomplished if necessary by using thin metal radials rather than a solid sheet conductor.

Mode of Operation of the "D.D.R.R."

There have been some variances of opinion on the way the "D.D.R.R." operates. The designer approaches it in this manner.

Studies of a 28 degree diameter electric array by techniques such as those developed by Chireix, show that with a 90 degree phase shift around the aperture an omni-directional radiation pattern in the horizontal plane will result. This is explained as follows:—

The combination of the radiator and the ground plane forms a type of "slot" antenna. From Fig. 1 it can be seen that the feed line launches a wave into the

curved "transmission line" or "slot" with the wave moving towards the open end at the speed of light.

If a discontinuity is introduced into a completely closed system, such as a conventional rectangular waveguide, the equivalent circuit of such a discontinuity will contain only reactive components because no power is lost in radiation. If however, the fields are not confined, but extend beyond the guide boundaries, then the discontinuity equivalent circuit contains both resistive and reactive components. Thus an extension effect is present in open wire transmission lines. If a transmission line such as we have constituted by the single conductor and ground plane runs in a straight line, it produces little radiation — shown by King and Storer in their article "Radiation Resistance of a Two Wire Line". This is because any discontinuities exist only at the ends of the line.

If the same single wire transmission line is bent into a curve however, a wave introduced at the input terminals encounters a completely different set of conditions. The bent transmission line can be seen as a series of directional discontinuities. Thus the transmitted wave is launched and radiated continuously in a direction which is transverse to the line axis throughout its entire length (Fig. 1 B). Radiation occurs from two sources. The first of these is a horizontally polarised wave produced from the current flow in the ring itself. This energy is cancelled by the field from the opposite current relation in the plane. At the same time vertically polarised radiation takes place from the higher order modes established by the discontinuity of direction.

The launched wave introduced into the transmission line arrives at the far end. The energy remaining at this point is reflected and radiates on its path back to the feed-line end of the radiator. Thus the "D.D.R.R." could be described as a leaky-wave guide radiator with radiation being integrated over its entire circumferential aperture.

Adjustment and Tuning of a "D.D.R.R." Array

As mentioned earlier, the "D.D.R.R." design is naturally resonant when the diameter is approximately 28 electrical degrees. The resonant frequency is relatively unaffected by the height H above the ground plane if kept well below 90 degrees.

Where a capacitor is included, tuning the array involves the adjustment of the capacitor for a minimum standing wave ratio on the feedline.

Any feedline from 36 to 500 ohms impedance can be used if dimension X is varied to suit. Thus the impedance matching network required with other short height designs is eliminated, together with the attendant electrical loss, and an additional restriction of reduced bandwidth. When first setting up a "D.D.R.R." installation, both capacitor and the feedline tap must be adjusted for minimum V.S.W.R. at the operating frequency. This is best accomplished by first resonating the antenna without the feedline connected, then connecting the feedline with adjustment for the lowest V.S.W.R. on the line.

Once the system has been correctly set up, the "D.D.R.R." antenna can then be capacitively tuned over at least a 2:1 frequency range without the V.S.W.R. exceeding 2:1. Either a low loss air or vacuum capacitor should be used for resonating the antenna. If an air spaced unit is used outdoors it must be protected from moisture, because of the high voltages present across it. In a typical installation, for 100 watts transmitter input power, the capacitor should be rated at about 4000 volts; at 1 Kw input, this rating should be in the vicinity of 15Kv.

If the conductor diameter is made too small, then the bandwidth of the device is reduced. As an indication of the various dimensions for the antenna, the table set out below lists a design for 6 of the low frequency amateur bands. The letters at the head of each column in the table refer to the dimensions in Fig. 1 A.

Band metres	D	H	d	A	X	pfds C
160	36'	48"	5"	18"	12"	100
80	18'	24"	5"	12"	6"	100
40	9'	12"	2.5"	6"	3"	75
20	4' 6"	6"	1"	3"	1½"	50
15	3' 4"	4½"	½"	2"	1"	35
10	2' 3"	3"	½"	2"	¾"	25

Performance of the "D.D.R.R."

No single antenna design is an answer for all the problems of communications, but the performance and flexibility of the "D.D.R.R." represents a refreshing new approach.

As an example of many of the field strength comparison made between the "D.D.R.R." and conventional quarter - wavelength vertical antennae; at 4Mc/s, the D.D.R.R. was only 2.5dB down in radiation efficiency. At the higher frequencies, the "D.D.R.R." has proved to be a convenient and efficient device for mobile communications. A mobile antenna designed for use between 26.5 and 31Mc/s is 27 inches in diameter and projects only 3½ inches above the vehicle roof. Some departure from a perfect omni-directional pattern is usually caused by the non-symmetrical ground plane geometry of the metal car body. Nevertheless, this is usually insignificant. In addition to its good radiation pattern, at high road speeds there is very little signal flutter effect. Grounded directly to the vehicle frame, thus providing a direct path for static and rain precipitation noise, the antenna helps to improve the signal to noise ratio of the system. One factor which may or may not prove useful is the sharpness of tuning of the "D.D.R.R." in that it is a high 'Q' device. This can be helpful during reception in rejection of adjacent channel and image signals and reduction in cross modulation effects.

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Looking at . . .

ELECTRONICS IN MEDICINE

Whilst electronics has played an important part in medicine for 30 years or more it is only since the development of reliable transistors that a real impact has been made on the science.

Prior to 1955 or so electronics was used externally — as a means of applying some treatment or diagnosis method to the patient — X-rays or electro cardiograms being two familiar uses. Miniaturisation due to semiconductors has meant that equipment can be placed within the body to both regulate its functions and to provide information on its functioning (or malfunctioning).

The present day field of medical electronics is so wide that to attempt to deal with the whole field would leave no field adequately covered so that we will attempt this month, merely to touch upon three uses of electronics, hoping to deal with some of the others in later issues.

Cardiac pacemakers, radio capsules and lasers — these three frequently hit the daily headlines and are thus good subjects for this month's Looking At, particularly as two medical units in New Zealand, the Southern Metropolitan Thoracic Surgical Unit at Dunedin Hospital and the Cardiothoracic Surgical Unit at Green Lane Hospital, Auckland, have had considerable experience with cardiac pacemakers.

Pacemakers

Heart blocks causing stoppage of the heart beat may result from a number of defects outside our present interest but in many cases the stoppages may not be fatal if the heart beat can be started again and maintained at the near normal pulse rate of 70, or so, per minute. Failure of a normal heart due say to electric shock can be overcome by re-excitation of the heart. Heart action immediately after an electric shock often becomes fibrillatory — a condition in which the beat becomes irregular and the heart muscles unco-ordinated. Eventually, this may result in death. However, if the heart can be re-coordinated in this case by external means, or defibrillated its action may return to normal without further impediment. Defibrillation in such emergencies is either accomplished through artificial resuscitation or in more extreme cases, by open heart massage. None of these methods employs electronics.

However, when the heart has a chronic defect not due to a transitory external cause such as irregular pulse rate or very low pulse rate (say 40 or below) surgical remedies are called for. Various drugs often give relief to milder forms of heart defects but attacks of the Stokes-Adams form, in which slow pulse rate and seizures are common, usually prove fatal unless remedial measures are instituted. The effect of electrical impulses on human muscles has been known for several hundred years and in 1819 Aldini in London suggested electrical resuscitation of the heart and in Boulogne in 1870 a successful attempt was made at electrical pacemaking. Regular stimulation of the heart muscles at pulse rate has been recognised as a control of the heart beat for some 30 years but it was not until 1952 that Zoll, in America, actively employed electrical stimulation to the heart as a pacemaking method. Zoll placed electrodes on the skin near the heart and applied voltages from 25-100 to reach the heart muscles but the discomfort to the patient is obvious. Within 5 years the electrode position became within the body with the electrodes fed (mechanically) through a vein to reach the heart muscles. By this time reliable transistors were coming onto the market and body worn pacemakers could be fitted but the obvious drawback of intravenous insertion of the electrodes was apparent and by 1960 the whole unit was capable of being implanted in the body tissue.

Pacemaker Techniques

The choice of pacemaking equipment and its position, internal or external, depends almost solely upon medical needs and can be classed as emergency short term or long term. For short term use external pacemakers are used with one electrode being inserted intravenously and the other attached externally. Except for extreme emergencies the total external electrode method is not used for any length of time. The external electrode, method may be used, as mentioned above, to relieve cardiac arrest and the defibrillation voltages are usually about 200 applied six or eight times. True pacemaking by this method, if required, is done with a voltage of about 70. The introduction of an electrode by a catheter down the jugular vein to the right ventricle of the heart will need only 2 or 3 volts at a pace of about 70 a minute.

Obviously a patient with a sudden onset of heart trouble cannot be adequately studied in a few hours and the fitting of an external pacemaker, coupled with drug therapy will give medical staff time to assess the patient's needs — both surgical and long term. American practice tends to confirm the theory that if the heart does not return to normal rhythm

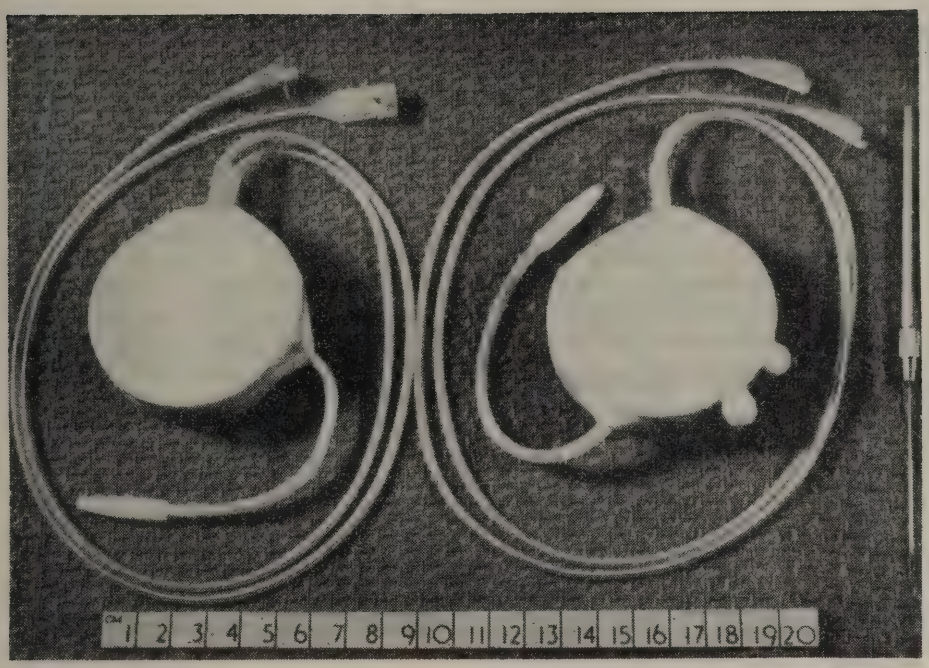


Figure 1.

within three weeks with external pacemaking then an internally implanted pacemaker is required. Implantation being the ultimate, has been preceeded by several alternative methods in addition to the intravenous injection of the electrode and their limitations are worth consideration:—

(a) A needle electrode thrust through the chest wall to the cardiac muscle and conected to an external pacemaker. This is an emergency method some American workers prefer over an intravenous injection but it is obviously a hazardous procedure.

(b) Wire electrodes can be connected to the heart muscles during a heart operation and brought out through the skin to an external pacemaker. This has two disadvantages; adequate connection to the cardiac muscle and possible irritation and infection at the skin puncture. Usually this method is limited to 10 or 14 days use. The two disadvantages of this method also apply equally to the intravenous method.

Providing the patient can tolerate an implantation, the physical limitations of the above methods can be removed with an internally imbedded unit.

Pacemaker Technical Details and Reliability

Cole and Yarrow (1) have published details of results at Auckland's Green Lane Hospital on 27 internal type pacemakers and their most extensive experience has been with Medtronic units such as shown in figure 1. Nearly all pacemaker units provide an output of from 3 to 6 volts for 2 milliseconds into a load impedance of 1000 ohms. Power is obtained from a mercury battery with a life of from 3 to 4 years. Encapsulation in epoxy resin inhibits moisture and an inert coating of silicone rubber is often used in addition. The connections to the heart provide something of a problem as they must withstand continuous movement for many years. Two types of wires are used; multi strand stainless steel or coiled platinum-iridium. In the Medtronic unit used by Green Lane Hospital the electrode is a portion of the connecting wire protected by a plastic shield arrangement as a terminal cover. The terminal is stitched to the heart with the electrode pushing into the cardiac muscle. Another make uses a flat coiled electrode held on the muscle by a plastic terminal whilst another method is to use a platinum electrode stitched directly to the muscle but this has a weakness at the joint between the connecting wire and the electrode plate.

Pacemakers can be of two types — fixed rate and adjustable rate. The former are called asynchronous as the rate used bears no relationship to the patient's heart activity. A synchronous unit can take its timing from the auricular impulse (loosely, this is at the natural pulse rate). Thus the latter type can be self regulating as the patient's rate changes with exercise. A compromise arrangement is possible as shown on the right hand unit in figure 1. Screwdriver adjustment of the pulse rate is possible through two nipples into which a needle screwdriver can be pushed through the skin and abdominal layers. The units in figure 1 have a small pigtail which can be placed close to the body surface and retrieved under local anaesthetic. This allows further control under emergency conditions or testing.

Figure 2 shows a radiograph of a pacemaker implanted in the left flank of the abdomen with the leads up to the cardiac muscles.

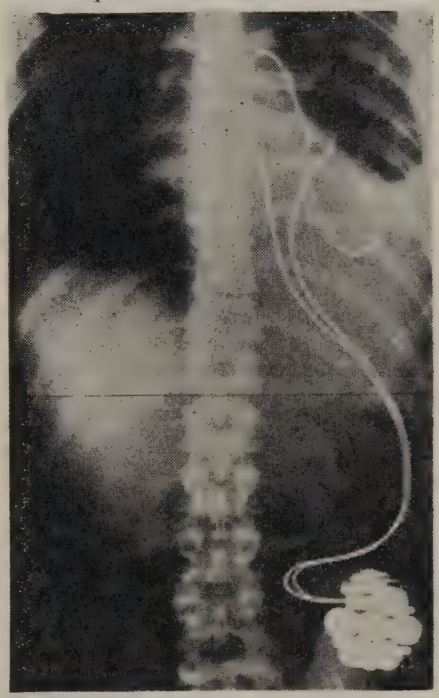


Figure 2.

Reliability can be seen from the table below:—

Type A — 4 units
2 voltage failures at 18 mths.
1 satisfactory for 16 mths.
1 electrode failure at 11 mths.

Type B — 17 units
14 satisfactory for 2-17 mths.

Continued on page 33

Compact Broad-band Balun Transformers

by
IRVING SPACKMAN,
A.M.I.E.E.E.

The "Balun transformer has been described in many texts under various guises. The name "balun" is alledgedly an abbreviation of the term "balanced to unbalanced." The most popular broad band types of balun are typified at one end of the scale, by the small ferrite cored 4:1 impedance transformers utilised in many TV tuners, and at the other end of the scale, by the physically large bifilar wound air cored used for lower frequency transmitting applications.

Other commonly used types of baluns are the $\frac{1}{4}$ wavelength coaxial "bazooka" used as a 1:1 impedance transformer and balancing section, and the $\frac{1}{2}$ wavelength 4:1 impedance balancing transformer, often called a "trombone", type of coaxial balancing system. These two latter types of balancing device are definitely narrow bandwidth systems, and are more suitable for high frequency operation, in that they are, in effect, tuned or resonant lengths of feedline.

In the last few years, a number of high frequency low-loss ferro-ceramic materials have become available. These materials are available in various shapes and configurations such as E and I and pot-type cores and toroids. The toroidal core is ideal for use in a broad band "balun" transformer because it is compact, generally mechanically quite robust, and the R.F. field is confined to the space bounded by the core and winding, so that stray fields are much reduced. By the use of these new materials it is possible to produce a matching transformer with small size, low loss, and broad band characteristics.

This article will be confined to the two types of baluns which are of most interest, namely the 1:4 impedance transformer converting from unbalanced to balanced termination with a 4 times impedance step-up, as used for instance when a 300 ohm folded dipole is to be fed from a coaxial line, and the 1:1 balancing transformer where it is desired to feed a balanced device such as a dipole antenna with an unbalanced feedline such as a coaxial cable.

Performance and Characteristics of Balun Transformers

The performance of these transformers can be determined using two approaches. At the high frequency end of their working range, they operate as transmission line transformers, whilst at the low frequency end of their range, they constitute tightly coupled coils with the low frequency response limited by the amount of winding inductance.

The important factor in the low frequency performance of these devices is quite obviously the type of core, and we will consider this next.

In any type of transformer, there are three distinctly separate circuits to be considered and these are:—

1. The Electric Circuit.
2. The Magnetic Circuit.
3. The Dielectric Circuit.

The losses associated with these three branches are briefly summarised as follows:—

I^2R Loss due to Load Current

Since the current is only determined by the load, the R values should be reduced to a minimum. This means that heavy conductors are required.

I^2R Loss due to Magnetising Current

This loss is quite small in normal low frequency transformer design where the magnetising current is of the order of 3-10 per cent of the full load current. With wide-band transformers the greatest loss is at the low frequency end of the operating frequency range.

In any transformer the input power will exceed the output power by the total losses. Thus there is a small increase in loss due to the extra primary current necessary to support these losses.

Eddy current Loss in Conductors due to Leakage Fields

This loss is caused by the eddy currents in individual conductors which are set up by the stray magnetic fields. This loss is impossible to calculate, but is usually small enough to neglect.

Hysteresis and Eddy Current Losses in the Core:

These losses are dependent on the grade of material and size of the core, and can be calculated within reasonable limits from data supplied by the manufacturers of the cores. These losses can be together quite significant in the overall total.

Now, ideally, a wideband type of transformer design should be such that when the secondary winding is terminated in resistive load, the reflected primary impedance should be also resistive in nature and equal to the characteristic impedance of the coaxial cable feedline over the entire design frequency range. In commercial service it is usually desirable to operate transformers of this type over a frequency range of at least 10 to 1, and it is desirable that the V.S.W.R. should not rise above 1.5 to 1 at the worst condition.

In general with amateur service there are two cases where such demands are made. The only single dipole which is required to operate over a wide frequency range is that of a 40 metre dipole being used as 3 half-waves on 15 metres. A somewhat different

application is the technique of feeding a multi-dipole system or trap isolated dipole at a number of frequencies.

Choice of Cores for Performance and Power Handling Ability

By suitable selection of core material, winding size and termination impedances it is possible to achieve very broad-band balun transformers. However, some of these factors are usually fixed — i.e. termination impedances and core material unless the latter is specially indented. For any one particular application, it is inevitable that there will be more than one grade of ferrite which is applicable and that no one grade will be ideal in its behaviour. The final choice is determined by considering the following characteristics:—

1. Permeability of the material.
2. Temperature effects, in particular, the Curie Point.
3. Resistivity.
4. Hysteresis loss.

From the data available it would appear that the Mullard grade B2, the Phillips 4C1 and the Ducon Q1 materials are suitable.

Since the transformer depends less on the core material at the high frequency end of its useful range, the core need not have an extremely high intrinsic Q factor. Materials having lower permeability however, will require the use of more turns to operate satisfactorily at the lower frequencies.

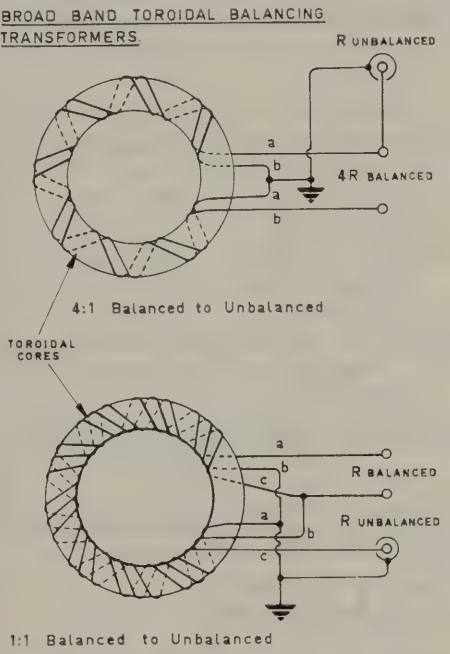
These materials are essentially non-conductive and any flaws or cracks in the core will seriously impair the performance of the transformer. In general the cross-section of the toroid ring should be square and the outside diameter to thickness ratio about 4 or 5 to 1.

The maximum permissable core losses per cubic centimetre depend on cross-sectional area with the figure permissable loss decreasing with increasing core size due to the extremely poor thermal conductivity of the ferrite. A figure of 0.1w/cm^3 has been quoted as acceptable, this corresponding to a temperature rise of 40 degrees C. in free air for cores up to 1 or 2 cm in radius.

For a given design, the maximum power that can be safely handled is determined by one or more of the following:

1. R.M.S. power into the aerial, coupled with,
2. Aerial mismatching.

In the case of excessive power, the core losses can cause excessive heating with consequent core destruction. When mismatching occurs, there is a possibility of increased voltage on the transformer



secondary giving rise to increased core loss and overheating, or damage to the winding due to electrical flashover.

General Constructional Details

Whilst it is possibly simpler to use enamelled copper wire for winding, it is necessary to protect the wire from damage due to the sharp edges of the toroid. In the writer's experimental units, run of the mill plastic covered and coloured hookup wire was used, as it was easy to handle, insulated and the colour coding aided final connection.

For outdoor use the presence of moisture which will affect the "Q" of the material should be prevented, preferably by the use of a weatherproof sealed enclosure. A possible technique here would be to enclose the balun and terminations for the feedline and the inner ends of the antenna by moulding or "potting" the complete system in epoxy resin.

The 4:1 Balanced to Unbalanced Transformer

As shown in the drawing the transformer consists of a bifilar coil wound on the toroid. The number of turns is not particularly critical, with preferably at least 12 per winding (24 total).

Connection as shown will yield the correct result providing the wire designations are maintained.

The most common applications of this type of balun are feeding a folded dipole with a coaxial cable, or matching a 70 ohm coaxial line to a 300 ohm balanced transmission line.

The 1:1 Balanced to Unbalanced Transformer

This is shown diagramatically in the second part of the drawing and a prototype is shown in the photograph.

In this case there are 3 wires used (Tri-filar wound) with wire designations and connections as shown.

The extra winding is necessary to complete the circuit path for the magnetising current, and as such, does not include the load but completes the path for the power source.

The balun shown in the photograph consisted of 3 sets each of 10 turns, wound with 10/.010 hookup wire on a Ducon Q1 toroid. The dimensions of this toroid are 1.350 inches, external diameter; 0.71 inches internal diameter; and depth of core 0.375 inches. This core should safely handle up to 200 watts without showing any signs of heating.

This particular balun is obviously suited for feeding a dipole, "trap" type dipole or multi-wire all-band type dipole with coaxial cable.

Over the frequency range 3 to 30 megacycles, the loss in the balun should be no more than 1dB.

In conclusion, the author has attempted to show the usefulness of wide-band ferrite cored baluns. The problems of connecting balanced to unbalanced lines are not fully understood or appreciated, as shown by the number of cases where balanced antennae systems are fed with unbalanced lines. Except in certain special cases,

Continued on page 35

ENQUIRY CARD AD. 10

imlok miniboxes
Miniboxes provide a simple and inexpensive way of housing a wide variety of small pieces of equipment. They are of simple two-piece construction — one half forming the top and two sides; the other the back, base, and front panel.
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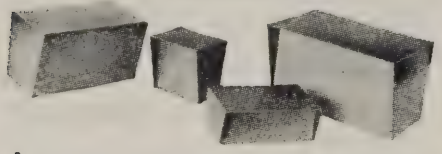

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RECENT SATELLITE NEWS

The distance of Explorer 22 satellite from the earth during its path over Europe recently was measured using a laser as a light source. The light was reflected from panels mounted on the satellite for this purpose. The distance was calculated to be 1,571,994 metres, accurate to plus or minus 8 metres. As far as is known, this was the first time such measurements had been carried out in Europe, although successful measurements have been made in the U.S.A.

Here is the latest information on satellites which are in orbit at the time of printing, and known to be within receiving range in New Zealand.

Ariel 1 (S.61). Orbit time 105 minutes—continuous carrier on 136.408Mc/s.

Ariel 2. Orbit time 106 minutes —continuous telemetry on 136.558Mc/s.

Tiros 4. Orbit time 105 minutes —continuous carriers on 136.23 Mc/s and 136.82Mc/s.

Tiros 5. Orbit time 104 minutes —continuous carriers on136.232 Mc/s and 136.923Mc/s.

Tiros 8. Orbit time 104 minutes —automatic picture transmission on 136.95Mc/s—continuous carriers on 136.26Mc/s and 136.92Mc/s.

Echo 2. Orbit time 109 minutes—continuous beacons modulated with telemetry signals on 136.02Mc/s and 137.17Mc/s.

Transit 4A. Orbit time 109 minutes —continuous carriers on 150 Mc/s and 400Mc/s.

Explorer 20. Orbit time 104 minutes—frequencies of topside ionospheric sounder 1.5; 2.0; 2.85; 3.72; 5.47; 7.22Mc/s. Telemetry on command from ground on 136.35Mc/s. Tracking Beacon on 136.68Mc/s.

Explorer 22. Orbit time 105 minutes—frequencies 20.005; 40.01; 41.01; 360.09Mc/s. Tracking Beacon 136.17Mc/s.

1964-83C. Orbit time 106 minutes. This satellite was launched in a true polar orbit on Dec. 1964 as a Radiation Satellite. Frequencies 162Mc/s and 324Mc/s c.w. on command. Telemetry continuously on 136.651Mc/s.

ENQUIRY CARD AD. 11

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To reduce labour costs.

To reduce tuner unit replacement costs.

To reduce uncertainty on intermittent tuner faults.

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ENQUIRY CARD AD. 12

RCA's Broad Economy Silicon Line Offers Blocking Voltages to 450 V Currents to 30 Amperes	12-Volt Supply/Inverter Power to 350 W/Audio Power to 100W/ Regulators Short-Circuit-Proof to 150W	Medium-Voltage/Inverter Power to 800 W/Audio Power to 300W/ Regulators Short-Circuit-Proof to 150W	High Voltage High Transients Inverter Power to 1KW Audio Power to 300W Regulators Short-Circuit-Proof to 150W
TO-5 AND FLANGED TO-5 I_c MAX to 1 AMP . P_t MAX = 5 and 10 W	**RCA 2N3053** V_{CEV} max 60V h_{FE} @ I_c = 150 ma 50-250 f_T 100 Mc (min)		**RCA 2N3440** V_{CEO} (sus) min 250V h_{FE} @ I_c = 20 ma 40-160 f_T 20 Mc (min) **RCA 40256** (TO-5 w/flange) θ_{j-c} = 15° C/W
TO-66 PKG. I_c MAX to 4 AMP . P_t MAX = 29 W	**RCA 40250** V_{CEV} max 50V h_{FE} @ I_c = 1.5A 25-100 f_T (typ) 1 Mc	**RCA 2N3054** V_{CEV} max 90V h_{FE} @ I_c = 0.5A 25-100 f_T (typ) 1 Mc	**RCA 2N3441** V_{CEV} max 160V h_{FE} @ I_c = 0.5 Adc 20-80 f_T (typ) 0.8 Mc
TO-3 PKG. I_c MAX to 15 AMP . P_t MAX = 117 W	**RCA 40251** V_{CEV} 50V h_{FE} @ I_c = 8A 15-60 f_T (typ) 0.5 Mc	**RCA 2N3055** V_{CEV} 100V h_{FE} @ I_c = 4A 20-70 f_T (typ) 0.5 Mc	**RCA 2N3442** V_{CEV} 160V h_{FE} @ I_c = 3Adc 20-70 f_T (typ) 0.6 Mc
TO-3 PKG. I_c MAX to 30 AMP . P_t MAX = 150W	**RCA TA-2650** V_{CEO} 40V h_{FE} @ I_c = 15A 15-60 f_T (typ) 700 Kc	**RCA TA-2544** V_{CEO} 60V h_{FE} @ I_c = 10A 15-60 f_T (typ) 700 Kc	**RCA TA-2645A** V_{CEO} 140V h_{FE} @ I_c = 8A 15-60 f_T (typ) 500 Kc

RCA announce economy silicon power range up to 30 amps

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VR.26

Circuit and

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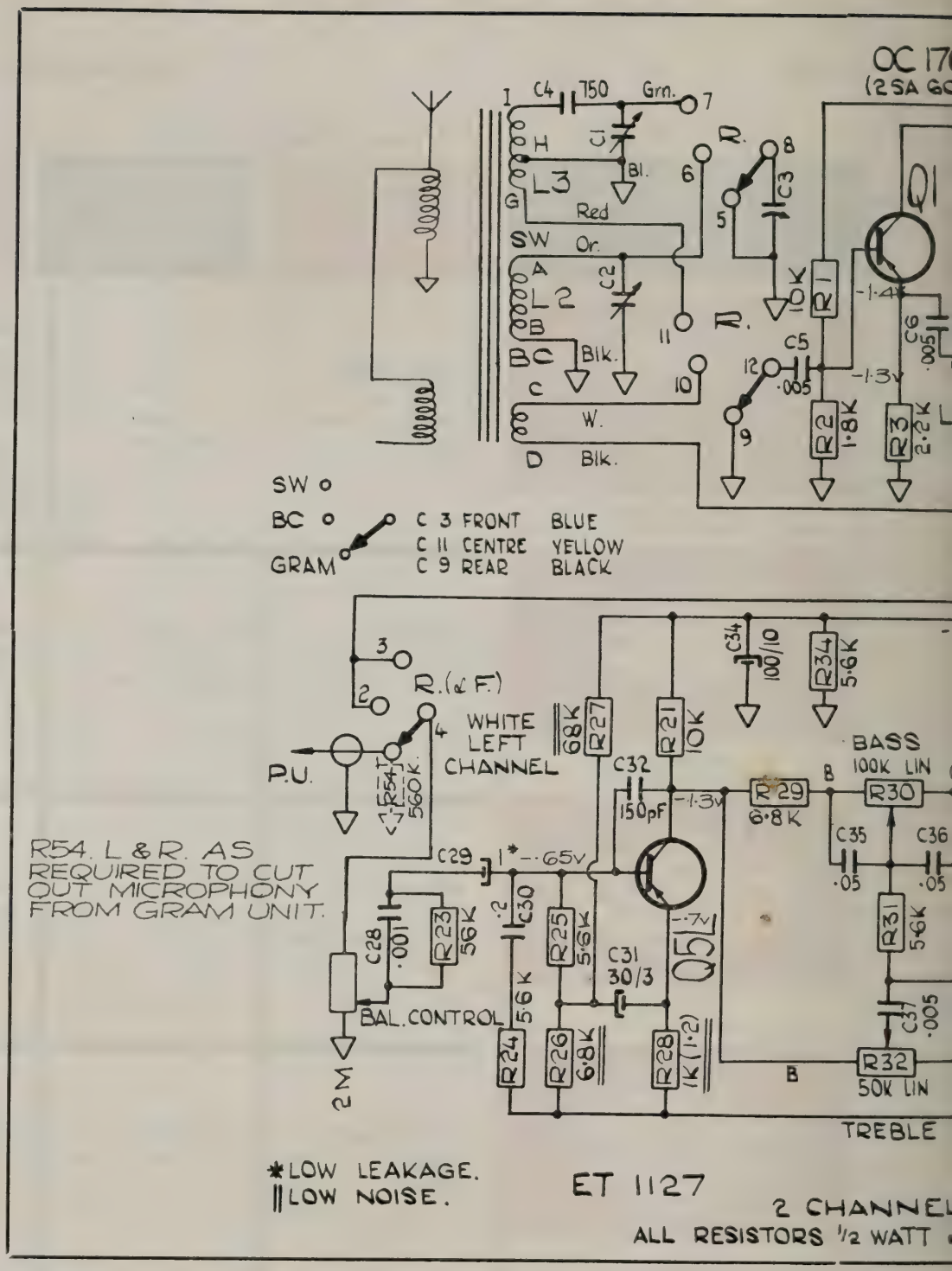
CYGNUS

Solid State

Stereogram



CYGNUS ALIGNMENT PROCEDURE

GENERAL. Allow test equipment to warm up for 10-15 minutes before starting alignment.

SIGNAL GENERATOR. Use A.M. signal generator, connect ground lead to chassis and output as indicated in the alignment chart.

OUTPUT METER. Connect across speaker voice coil connection load 10 ohm.

OUTPUT LEVEL. Attenuate the signal generator output throughout the alignment so as to maintain the output level below .5 watt.

CONTROLS. Set volume control at maximum, adjust tone controls for maximum output, tuning control as in the chart, reverb control at minimum.

POINTER. Set at zero on logging scale.

FREQUENCY RANGE:
B.C. 520 — 1625 Kc/s
S.W. 6 — 16 Mc/s

INTERMEDIATE FREQUENCY:
455 Kc/s

TRANSISTORS:
OC 170 Convertor
2SA53 1st and 2nd IF
2SB54 1st and 3rd AF
ET1127 2nd AF
2SB56 AF Driver
2SB80 P.P. Output

SPEAKERS:
4 — 6" P.M.

DIODE:
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THERMISTOR:
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POWER O.P.
6 Watt each Channel

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230 Volt 50 c/s
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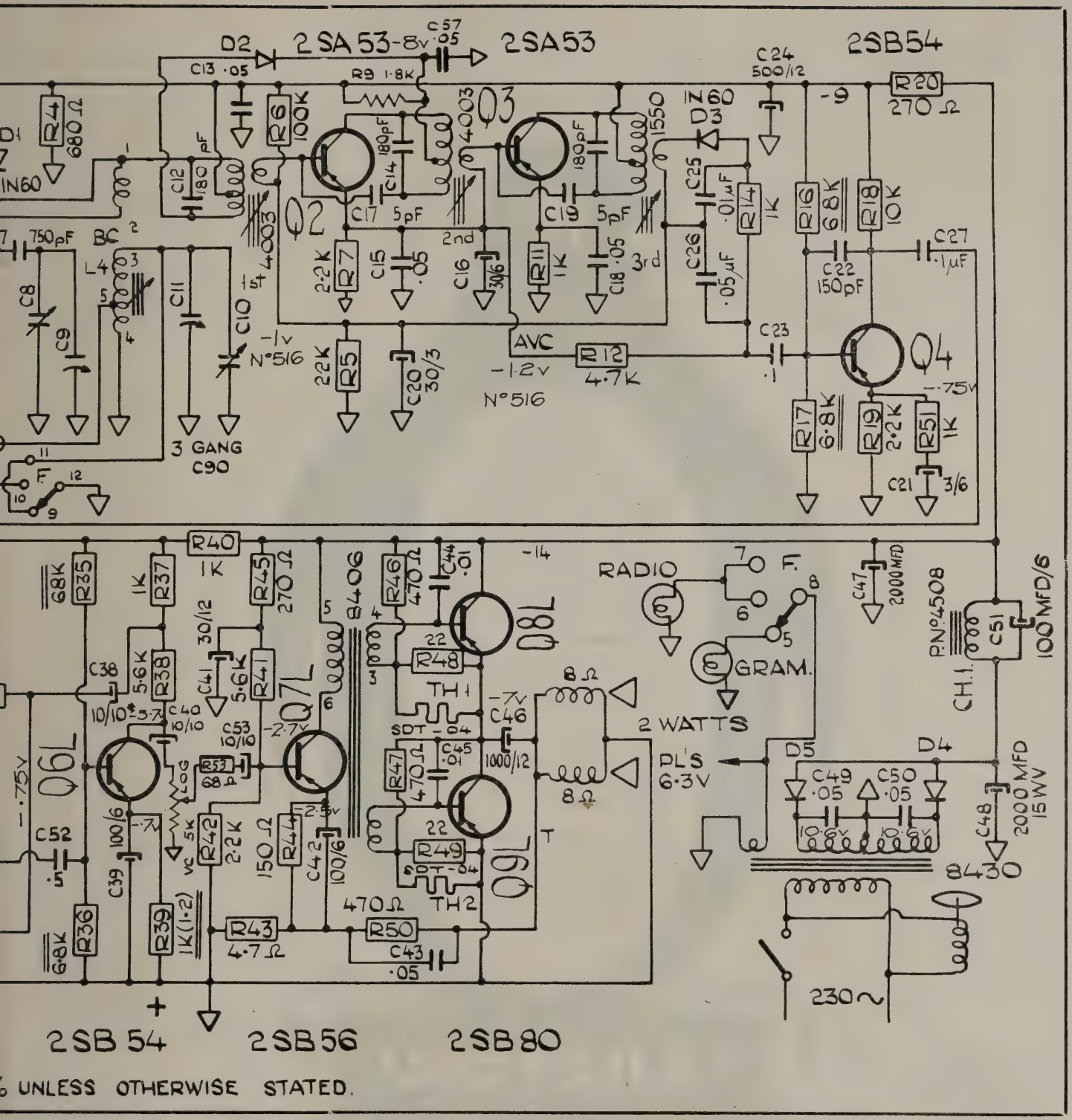

CONNECTION TO RADIO	FREQ.	DIAL SETTING	SPECIAL INSTR.	ADJUST
1. Connect S.G. through .1 μF capacitor to OC1 70 base.	Mc/s .455	Mc/s H.F. end	Adjust for max. in order given.	IFT 32
2. Connect S.G. through dummy ant. to aerial.	.6	.6	Adjust for max. oscillator core B.C. antenna core.	BC Osc Coil
3. A (2)	1.4	1.4	Adjust for max. oscillator trimmer and antenna trimmer.	C10 C2
4. Repeat (2) and (3) until no further improvement.				
5. As (2)	6.5	6.5	Adjust for max. S/W1 ant coil.	C8
6. As (2)	15	15 (S/W1)	Adjust for max. S/W1 ant and osc trimmer.	C1
7. Repeat (5) and (6) until no further improvement.				

NOTE: Outputs must not be short circuited to earth, damage to transistors may result.

ENQUIRY CARD AD. 13

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SERVICEMAN'S COLUMN

Conducted by J. Whitley Stokes

It goes without saying, or should do, that the first step in forming a diagnosis is to question the user as to the nature of his complaint. Where it is a case of sudden failure with no prior history of any other symptoms there is not much the owner can say except to relate this fact. It is a different story however when an intermittent fault is involved whether actual or merely suspect, as it is here that the accurate description of what took place can be of inestimable value to the serviceman. In this connection it is as important that the serviceman should be as proficient in his questioning of the owner as he is in interpreting meter readings.

This matter of getting the customer to talk, although the important first step in forming a diagnosis, must be learnt by experience. Many owners seem to have a natural reluctance to supply the required information without considerable prompting. Certainly some will be only too ready to tell you what **they** think is wrong, but this is not what is required. To digress for a moment, why is it always "I think it's **the** condenser". Sometimes if I'm feeling rather niggly I reply politely "Just which condenser do you think is at fault?" This usually brings a blank stare coupled with the remark "Is there more than one?" This insistence on one condenser can perhaps be attributed to occasions when the condenser in the owner's car, or motor mower has had to be replaced.

The other commonly heard utterance is "It's probably only a valve gone". I wonder if there is any significance in these statements—certainly they are uttered with monotonous regularity. Regarding the first one my own opinion is that in this increasingly technological age a non-technical owner may have a certain feeling of inadequacy when one of his electronic gadgets goes wrong. He or she is forced to rely on someone who has the necessary technical knowledge to restore it to working order, yet does not like to appear wholly ignorant of the workings of the particular item. The second, "only a valve" utterance can usually be attributed to a person who can best be described as a tightwad. What he really means is — I **hope** it's only a valve gone therefore it won't cost much.

But to return to the matter of obtaining useful information from the owner, it is important to realise that the two parties don't always talk the same language. For example to a serviceman the term "noisy" is a very different thing from the same term as understood by the owner. The latter will most likely use this term to describe his neighbour's set being played too loudly. Thus the serviceman must learn to phrase his questions so as to make it easy for the owner to give the required answers, but this must be done without giving him any feeling of being interrogated. Even so as mentioned earlier there is still that often encountered reluctance to "tell all". This is more frequently the case with women owners (I wonder why) particularly this seems to be true when the article has been dropped or otherwise misused. Could it be that the owner does not like to be thought clumsy or careless? Here again too, the question of expense enters into the situation. Apparently the same erroneous reasoning that prompts a patient to withhold information from his doctor out of fear that the doctor may find something wrong, impels some owners not to volunteer the admission that they have had a mishap because the repair might then be more expensive. If only such people could be made to realize that they are only helping themselves as well as the serviceman by withholding nothing.

Still, there will always be those jobs where direct contact with the owner is impossible or where any prior history is unknown as in the case of second hand articles. Perhaps rather a lot of space has been devoted to this first step to diagnosis yet it is important.

Book Review . . .

HOW TELEVISION WORKS

By W. A. HOLM

Second and revised edition 1963. 352 pp. Published by Philips Technical Library.

This edition closely follows the original and is only slightly larger than it. The book is divided into seven parts as follows:— 1. Principles of Picture Transmission. 2. The Cathode Ray Tube. 3. Pickup Tubes. 4. The Video Signal. 5. Oscillations: Electronic Tubes: Pulses. 6. The Complete Television Signal. 7. The Television Receiver.

From this it can be seen that all aspects of the transmission and reception of television signals are dealt with, though necessarily fairly briefly in the space available. It is a book well suited to help anyone with some knowledge of radio to gain an insight into the many differences and complexities of television. In a book of this nature it goes without saying that colour TV is not mentioned.

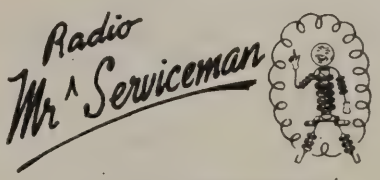
There are numerous diagrams which assist greatly in the explanations and a useful index is included.

It is noted, however, that some discrepancies present in the original edition in the section dealing with dipole aerials, remain uncorrected.

Our copy from Philips Electrical Industries of N.Z. Ltd. N.Z. price £1/15/0. —J.W.S.

—FURTHER REVIEWS ARE ON PAGE 35

ENQUIRY CARD AD. 14



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Write for alignment procedure Sheet No 5/40

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LISTENING POST

by michael lawrence

The following is the first part of a list of short-wave stations, heard during the first week of May, which beam their transmissions to the N.Z., Australia and Pacific area. As much of this information should remain unchanged until, at least, the first week of September, it should be of value to DXers.

Please note that not all of the transmissions are in English, times GMT and frequencies are given in kilocycles.

Freq. Kc/s	Station	Time GMT
5970	Canada	0730 - 0830
5980	Deutsche Welle	2100 - 2200
5985	VOA Dixon	0900 - 1530
6010	Rome	2030 - 2115
6025	Holland	0700 - 0800
6050	HCJB	0700 - 1030
6080	New Zealand	0600 - 0845
		0900 - 1145
		1700 - 1945
6090	Sydney	2000 - 1415
6100	Belgrade	1830 - 1900
		2200 - 2215
6110	BBC London	0600 - 0800
6140	Papeete	1615 on
6150	Melbourne	0800 - 1400
6175	France	0600 - 0645
7130	BBC London	2245 - 0330
7150	BBC London	0600 - 0845
7170	Noumea	2330 - 0200
7190	Melbourne	0700 - 1215
7200	Belgrade	2200 - 2215
7250	Vatican	2200 - 2215
7275	Rome	2030 - 2115
7285	USSR	2100 - 2200
9505	Belgrade	1530 - 1600
		2200 - 2215
9510	BBC London	0600 - 0800
9520	Denmark	0900 - 1000
9525	Holland	0600 - 0900
9530	Deutsche Welle	2110 - 2200
9540	New Zealand	0600 - 0845
		0900 - 1145
		1700 - 1945
9545	Switzerland	2100 - 2230
9560	France	0600 - 0645
9570	Melbourne	0645 - 0915
9575	Rome	2030 - 2115
9585	Djakarta	1100 - 1200
9600	Melbourne	1800 - 2115
9610	Perth	2200 - 1615
9625	Canada	0730 - 0830
9630	Vatican	2200 - 2230
9640	BBC London	0600 - 0845
9650	VOA Honolulu	0900 - 1230
9660	Brisbane	2000 - 1415
9665	VOA Dixon	0900 - 1115
		1200 - 1530
		1600 - 1630
9675	Poland	0700 - 0900
9680	Melbourne	2200 - 1415
9710	Rome	2030 - 2115
9715	Holland	0700 - 0750
9725	BBC Singapore	0900 - 1115
9735	Deutsche Welle	0645 - 0945
9745	HCJB	0700 - 1000

Next month I will complete the list with frequencies from 11Mc/s through to 21Mc/s.

STATION NEWS

GERMAN DEMOCRATIC REPUBLIC: Radio Berlin International has been heard recently broadcasting in English as follows:—

To Central Africa on 11795 from 0415 to 0445 at fair strength but with moderate interference.

To South East Asia on 15240 from 0700 - 0730. This signal was very weak but free from interference.

Also to South East Asia, on 11795 from 1530 to 1600. This was quite a strong signal but Deutsche Welle was equally as strong on the same frequency for most of the transmission period.

Other announced times and frequencies are 1200 - 1300 on 15240 and 11795kc/s and again at 1400 - 1500 on 15240kc/s.

U.S.A.—RED LION: Reception of WINB has been good on 11795 between 2100 and 2200 GMT but Deutsche Welle occupies the same frequency from 2140 GMT.

INDONESIA: The Voice of Indonesia at Djakarta transmits to Australia and New Zealand between 1100 and 1200 GMT on 9585kc/s.

SPAIN: From Madrid the Voice of Spain broadcasts in English from 0300 to 0345 on 6130kc/s. The signal from this transmitter is a strong one, however, the modulation appears to be very low making the programme rather difficult to understand. Other listed frequencies of this station were checked but none could be heard operating in parallel with the 6130 outlet.

SWEDEN: In transmission to the Far East, Radio Sweden transmits on 15440kc/s between 1230 and 1345, however, the signal is a very weak one. The English section is from 1230 - 1300 GMT.

BULGARIA: Sofia broadcasts in English 1930 - 2000 on 6070kc/s.

POLAND: The same time of 1930 - 2000 also applies to the English broadcast to Europe from Radio Warsaw. The frequency in this case is 6135 and reception in New Zealand is good.

CANADA: Radio Canada has eliminated their repeat broadcast to Australia and New Zealand between 0800 and 0850 and now broadcasts a one hour programme from 0730 to 0830 on 5970 and 9625kc/s.

GREAT BRITAIN: From Sunday 30th May onwards the BBC Pacific Service will transmit its daily programme directed to Australia and New Zealand at 0615 - 0700 GMT instead of 0800 - 0845. Frequencies in use will be 11,955, 9640 and 7150kc/s.

THAILAND: Four transmissions are broadcast daily in the Overseas Service of Radio Thailand.

Continued on page 31

MOBILE COMMUNICATIONS

Part II

*by Countryman**

Breathes there a technician with soul so dead, who, on looking through the many Instrument Catalogues, has never said, "Boy, could I use one of those." Which is just another way of saying that test gear is of perennial interest to all radio men, and especially those who make their living using it. A cursory glance at the glossy overseas trade journals will show that some really wonderful test gear is readily available. What it won't show, however, is the price which may easily run into four figures. An experienced senior technician commented the other day: "It is probably just as well they are dear, for with too much gear you turn your serviceman into a physicist." At the same time too little or too poor a range of test gear means that you can never be sure that things are right, and the morale of the people called upon to cope with a variety of sets with this gear is liable to suffer.

It must never be forgotten however, that the real test instrument is the brain, and no amount of instruments with shiny panels and flashing lights will replace the ability to think. All the instruments can do is present more or less correct data to the eye, and then it's up to the brain to interpret it. Having said all this, then what sort of instruments do we need to undertake the maintenance of mobile and fixed radio telephone equipment?

We can of course start off with a few standards. First of all a good, and I mean GOOD multimeter. There are any amount of these on the market and prices can range from well under £10 up to £50 or so. Most meters are of the order of 20,000 ohms per volt, and have ohms AC and DC volts and DC current ranges. Very few have AC current ranges, but I find that such a range is very useful if you want to make any signal to noise ratio tests, because you can put it in series with the voice coil and read the results directly off the dB scale. Of course you can put a meter across the voice coil and measure the voltage, but it gets pretty earsplitting if you have it on for a while. Another worthwhile facility is a polarity reversal switch on the ohms scale, because this vastly facilitates the testing of transistors without unwiring them from the circuit.

A signal generator is of course a must, and the better the quality the better the results. It has to be realised however that the signal generator has its limitations, and you cannot expect it to perform miracles. Discussing this with a friend the other day we came to the conclusion that the most important features are good stability, so that you don't have to chase it up and down the dial while you are aligning; and a reasonably accurate attenuator which you can reset to the same value every time you use it. After that its nice to have good calibration, (but of course for mobile alignment you would never trust a dial setting, you always set it against a crystal calibrator or frequency meter); and good clean low distortion modulation. This is most important if you are working on a set that is only one link in a chain, such as the receiver of a link at a remote transmitter site. In cases like this it's essential to set up each section for lowest possible distortion, and you can't do that with a generator that is badly modulated.

An audio generator and an oscilloscope are very important in transmitter work and of course a valve tester is handy even if it is not absolutely indispensable. Probably a V.T.V.M. is next on the list, and a frequency meter or crystal calibrator is very handy. What about a transistor tester? For most field work they are not necessary because simple go/no-go tests with a multimeter are usually adequate. In any case the messy business of unsoldering transistors and resoldering may well cause as much trouble as the original fault.

RECEIVER ALIGNMENT

Where a high standard of performance is required from a receiver, and with the very close channel allocations used nowadays, extremely accurate alignment is required. Nowadays most receivers are crystal controlled. That is to say the receiver local oscillator is crystal controlled, so that the accuracy of alignment depends on (a) the frequency of the crystal, and (b) the alignment of the IF stages. Most sets are designed with the local oscillator frequency to be above the signal frequency by the I.F. (in single, conversion superhet receivers). Thus for a mobile receiver on say 2.4Mc/s with a 455kc/s I.F. the receiver crystal would be on 2855 kc/s. However crystals are normally cut to work into a specific capacity and in a parallel resonant circuit. If for any reason the shunt capacity is different, then the crystal can easily be as much as several kilocycles away from its nominal frequency. Thus it will be necessary to ensure that the crystal is spot on or that the I.F. is adjusted to suit. With the very close channels it is essential to ensure that the skirt of the selectivity curve is as straight-sided as possible, if adjacent channel interference is to be kept to a minimum. These requirements place a premium on stringent alignment.

For receiver alignment the writer is a confirmed wobbulator man. The advantage of having a visual presentation of the response of the receiver, so that the effect of the adjustment of every slug or trimmer is immediately visible, is so great that I cannot understand the reluctance of many to use it. Quite clearly if proper attention is paid to skirt response and accurate frequency alignment,

Continued on page 33

* a pen name for a New Zealander widely experienced in M.F. and V.H.F. communications systems.

ENQUIRY CARD AD. 15

REDFERN TRANSISTOR INVERTERS

FOR EMERGENCY POWER SUPPLIES

New 350 Watt 12V D.C. to 230V 50.CPS A.C. INVERTER Model powers ¼" Electric Hand Drill, Lamps, Soldering Irons, Electronic Equipment up to 350 Watt Power rating.

FEATURES remote control connections, frequency and drive control, load indicator lamp, twin 230V Outlets, reverse polarity protected, Start run switch with centre off fitted, operating instructions printed on front panel. Available accessories — Redfern Sine Wave Filter Regulator Unit for obtaining Sine wave outputs, emergency change-over relay unit, electronic controlled battery charger.

These units may be combined to form an emergency no-break power supply to maintain essential services during A.C. mains failure.

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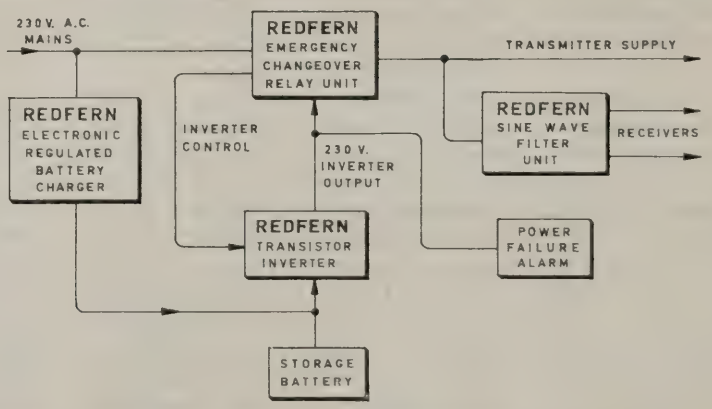

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MANUFACTURERS & DISTRIBUTORS

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Portable Atomic Frequency Standard

A rubidium-vapour frequency standard developed by the National Bureau of Standards (U.S. Department of Commerce) combines the accuracy and stability of atomic standards with easy portability and independence of power lines. Based on a transition frequency of the rubidium atom (6834.68 MHz), the device uses a rubidium lamp which stimulates rubidium vapour to undergo the required transition.

The portable atomic standard was designed for the National Aeronautics and Space Administration (NASA) by a team of NBS scientists: Robert J. Carpenter, Sachio Saito, Robert O. Stone, Dr. Earl C. Beaty, and Dr. Peter L. Bender.

The rubidium vapour standard has a short-term stability better than 1 part in 10^{10}, recommending it for use both as a clock and as a frequency standard. Lightweight and requiring approximately 23 watts of power, it is useful for synchronising clocks in isolated areas to which it can be transported. Normally it operates from conventional A.C. power; if power is removed it switches automatically to self-contained batteries for approximately 8 hours of operation at room temperature.

NEW E.D.A.C. HEAD

Mr. F. L. Fuller has been appointed general manager of Electronic Development and Applications Ltd. (E.D.A.C.), in succession to the late Mr. Ralph Slade. Mr. Fuller is also a member of the Board of Directors of the company.

The appointment was announced by Sir Arthur Harper, Chairman of Directors of E.D.A.C., which is an associate company of Philips Electrical Industries of New Zealand Ltd.

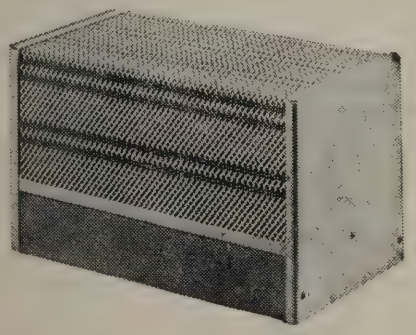
Mr. Slade, who has been in charge of E.D.A.C. since its inception in 1954, died in February. A well-known personality in the radio, television and electronics industry he was widely respected for his intimate knowledge of the industry as a whole, for his major contribution to its development, and for his high standards of integrity.

Mr. Fuller, who succeeds Mr. Slade in the control of E.D.A.C., has also been associated with the company since its inception and worked very closely with the late Mr. Slade during the whole of that period. He also is a well-known figure throughout the industry.

ENQUIRY CARD AD. 16

RADIO HOBBYISTS AND ENTHUSIASTS

WE SUPPLY CHASSIS, CABINETS, PRINTED CIRCUITS, TRANSFORMERS, COMPONENTS, Etc.



18 Gauge Blank Aluminium Chassis

Complete with base, expanded steel mesh cover and rubber feet. Standard finish in Grey, Green or Brown Hammerglaze.

Sizes: 8 x 4 x 2, 11 x 6 x 2, 12 x 8 x 2, 14 x 10 x 2.

18 Gauge Aluminium Chassis

Available with **inside** or **outside** mounting flanges.

18 sizes x 2 ways = 36 chassis. Base available for inside flange-type. All Fryco aluminium chassis have riveted ends.

"Ten-Trans" DC-DC Converters

Available ex-stock as follows:—

30 Watt 12 VDC – 250 VDC – 120 MA (Also available as Kitset)

Complete Units Only:

40 Watt 12 VDC – 150 and 300 VDC – 135 MA Total

50 Watt 12 VDC – 150 and 300 VDC – 165 MA Total

75 Watt 12 VDC – 250 and 500 VDC – 150 MA Total

The price of these units range from £7 to £15.

The voltage and current ratings of these converters are flexible and can be made to your own special requirements. Return mail guaranteed. Specification data supplied on request.

We specialise in printed circuit boards, transformers, components and metalwork for Mullard, Electronics Australia (R.T.V. and H.) and other circuits. We also make your special to order. Full information and prices of our ever-increasing range given on request.

RADIO TRADERS LTD.

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ELECTRICAL MEASURING UNITS

Continued from page 11

implies a method of deriving the ohm. If the permeability of free space is known, we have seen that it is possible to compute the inductance of a coil from its dimensions. If inductance is known, it is theoretically possible to derive resistance through inductance.

Deriving the Ohm

The mutual inductor and the circuit shown in simplified form in Figure 4 provide a method of

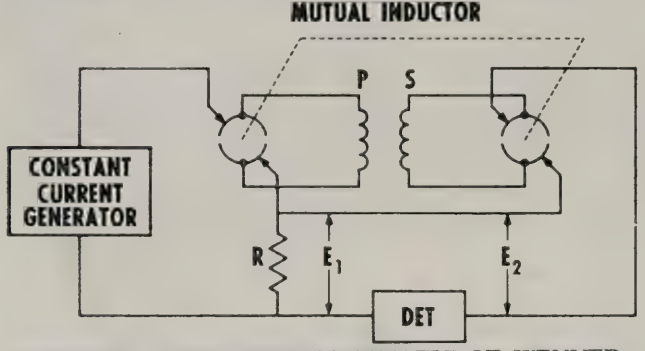

FIGURE 4. SIMPLIFIED SCHEMATIC OF WENNER METHOD OF DETERMINING RESISTANCE

determining the resistance of a resistor in terms of the dimensions of the mutual inductor and the frequency of the commutator.

The primary commutator reverses the voltage across the primary of the mutual inductor. The voltage reversals cause an alternating current in the secondary, and the current is rectified by the secondary commutator which rotates synchronously with the primary commutator. If the current fed to the primary commutator is constant, the average voltage across the secondary commutator, E_2, is:

$$E_2 = 4Ifm$$

where I is the primary current, f is the commutator frequency, and m is the mutual inductance.

The resistance or the frequency are adjusted to make the galvanometer read zero, in which case the voltage across the resistor, E_1, is equal to E_2. Since:

$$E_1 = IR$$

and

$$E_2 = 4Ifm$$

at balance

$$E_1 = E_2$$

so that

$$IR = 4Ifm$$

or, dividing by I;

$$R = 4fm$$

The measurement of frequency in terms of atomic resonance can be made several orders of magnitude more accurately than the other factors of the equation, and the mutual inductance is determined by mechanical measurements. From these, the resistance can be calculated.

Of course, the actual circuit is not so simple. Actual circuits never seem to have the classic simplicity that the fundamental circuits do.

The major complications involve the regulation of the primary current, the production of wave forms that have predictable shape, and delivery of sufficiently smooth average voltage to the galvanometer. With this method, the National Bureau of Standards has determined the absolute value of the ohm with an estimated accuracy of 5 parts per million.

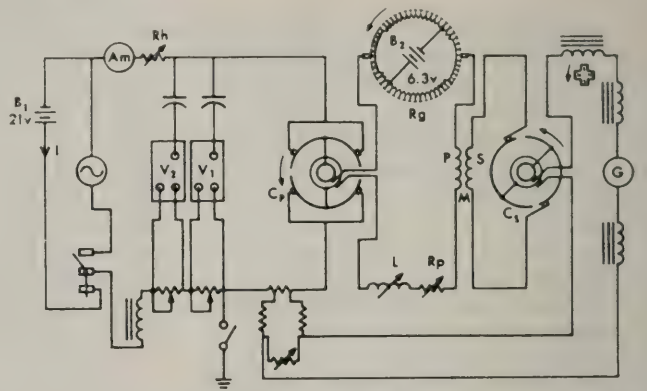

FIGURE 5. COMPLETE SCHEMATIC OF WENNER METHOD

The Ohm and Capacitance

Another way to find the absolute value of the ohm is to build a capacitor with a capacitance that can be calculated from its physical dimensions and build a circuit that compares resistance with capacitive reactance at a known frequency. This is the method currently used by the National Bureau of Standards.

Capacitance

A. M. Thompson and D. G. Lampard of the Australian National Standards Laboratory have developed a type of capacitor for which the capacitance can be calculated more accurately than any previous design. A theorum published by Lampard in 1956 shows that a cross-capacitor constructed with electrodes that are parallel cylinders of arbitrary cross section, and so constructed that the cross-capacitances are equal, will have cross-capacitances that can be calculated from the single measurement of length, S, by the formula:

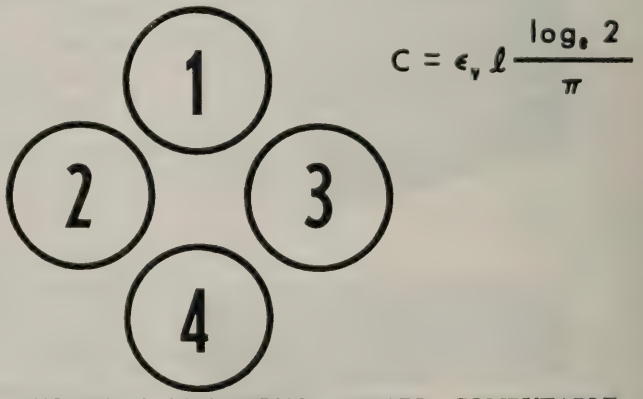

FIGURE 6. THOMPSON-LAMPARD COMPUTABLE CAPACITOR

A particular case of this theory is illustrated by a cross-capacitor constructed of circular cylinders, as shown in Figure 6. If Electrodes 2 and 3 are grounded, the capacitance between Electrodes 1 and 4 is measured, and then Electrodes 1 and 4 are grounded and the capacitance between Electrodes 2

and 3 is measured. As the two capacitances measured in this way approach equality, the value of either capacitance approaches a constant value per unit length. This constant value is approximately 2 picofarads pϕ meter.

It should be noted here that one of the factors of the constant value per unit length of a calculable capacitor is the permittivity of free space, Ev. Permittivity, Ev, and permeability, μv, of free space are related as follows:

$$E_v = \frac{1}{\mu_v C^2}$$

where C is the speed of light. As stated before, permeability of free space is defined to be equal to $4\pi \times 10^{-7}$. If the speed of light were known exactly, it would be possible to find the permittivity of free space exactly. This means that the accuracy of the derivation of capacitance depends on the accuracy with which the speed of light is known.

Another way to derive the Ohm

With a circuit similar to that shown in Figure 7, one can compare capacitive reactance and ac resistance. In order to do so, the two generator voltages must be exactly 90° out of phase.

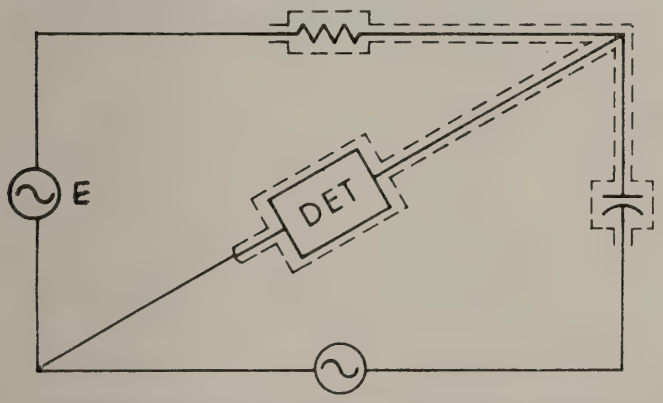

FIGURE 7. CAPACITIVE REACTANCE BRIDGE SCHEMATIC

In order to correct for several effects, including errors of phase and residual capacitances and resistances, the National Bureau of Standards has performed the experiment of comparing capacitive reactance and ac resistance using the frequency-dependent bridge shown in Figure 8.

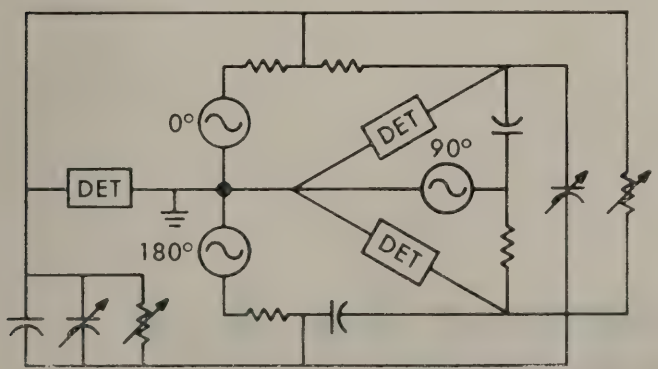

FIGURE 8. FREQUENCY-DEPENDENT BRIDGE SCHEMATIC

AC to DC Transfer

Once the ac resistance has been derived, it is necessary to transfer to dc resistance. This is accomplished by using a special resistor which has very low capacitive and inductive residuals. The National Bureau of Standards estimates that the probable accuracy of this method of deriving dc resistance through capacitance is ±2.1 parts per million, excluding errors caused by uncertainty of the exact speed of light. The speed of light is believed to be known within one part per million.

Thus it is possible to form another chain of derivations from fundamental standards using capacitance instead of inductance. Figure 9 shows such a derivation; another derivation of units from fundamental standards.

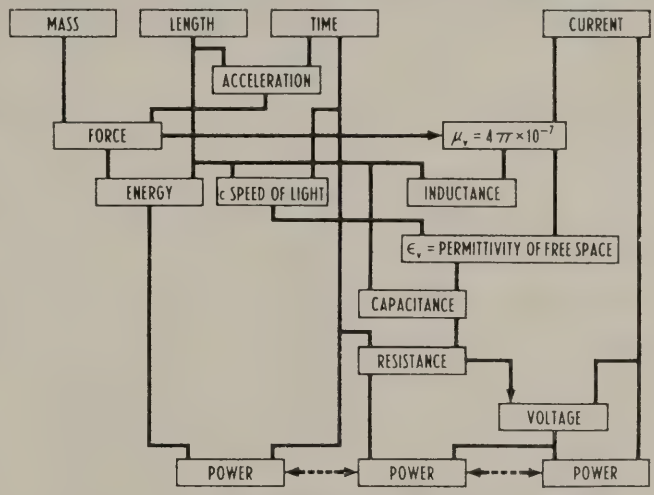

FIGURE 9. A DERIVATION OF UNITS USING CAPACITANCE

Other electrical quantities, such as voltage, must be transferred from ac to dc or vice versa. For this reason, there is a branch of measurement devoted to ac to dc transfer.

Ratios

We have seen that the MKSA values for voltage, resistance, current inductance, and capacitance can be derived from the fundamental standards of length, mass, and time, and as a matter of fact, inductance and capacitance can be computed solely from dimensional measurements. These computations are based on the assumption that is implied in the definition of current: that the permeability of free space is $4\pi \times 10^{-7}$.

In general the devices and experiments used to relate electrical and mechanical measurements give one result per experiment. The result is a current of a specific size, a certain inductance, a specific capacitance, or a resistance of a certain value. The next problem is to find multiples of each known value. This problem is similar to the problem of manufacturing a set of weights if you are given only a kilogram as a start.

Many electrical quantities, such as voltage, resistance, current, capacitance, and inductance, can be transferred to different values by using known resistance ratios or transformer ratios. Since the ratios do not involve the accuracy or value of the

ENQUIRY CARD AD. 17

OUTPUT TRANSFORMERS to your requirements

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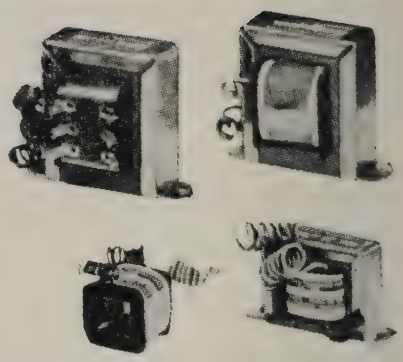

We Manufacture many types of Output Transformers for New Equipment and Replacement Repair Work.

WINDINGS AVAILABLE FOR OP1-14 and OP18-22 INCLUSIVE

Type No.	Wattage	Impedance Ratio	Bobbin Size	Colour Code	Mounting
†OP1	3	5K/3 ohms	9/16 Square	Red	Clamp
†OP2	3	7K/3 ,,	9/16 ,,	Yellow	,,
†OP3	3	10K/3 ,,	9/16 ,,	White	,,
†OP3 C	3	10KCT/3 ohms	9/16 ,,	White	,,
†OP4	6	5K/3 ,,	¾ Square	Red	,,
†OP5	6	7K/3 ,,	¾ ,,	Yellow	,,
†OP6	6	10KCT/3 ,,	¾ ,,	White	,,
†OP7	6	14KCT/3 ,,	¾ ,,	Black	,,
†OP8	4.5	5K/3 ,,	11/16 x 13/16	Red	,,
†OP9	4.5	7K/3 ,,	11/16 x 13/16	Yellow	,,
†OP10	4.5	10KCT/3 ,,	11/16 x 13/16	White	,,
†OP11	4.5	14KCT/3 ,,	11/16 x 13/16	Black	,,
†OP12	4.5	Universal	11/16 x 13/16	—	,,
†OP13	6	Universal	¾ x ¾	—	,,
†OP14	10W	Universal	⅞ x ⅞	—	,,
OP15	20	5KCT/Univ.	1" x 1¼	—	Side covers & feet
OP16	20	6.6KCT/ ,,	1" x 1¼	—	,,
OP17	20	10KCT/ ,,	1" x 1¼	—	,,
OP21	2W	5K/3	½"	Red	Windings Only
OP22	2W	7K/3	½"	Yellow	,, ,,
OP23	35W	5KCT/Univ.	2" x 1¼	—	Covers & Feet
OP24	35	6.6KCT/ ,,	2" x 1¼	—	,, ,,
OP25	35	10KCT/ ,,	2" x 1¼	—	,, ,,
OP26	15W	Hifi 5KCT/15 ohms	2" x 1¼	—	,, ,,
OP27	15W	Hifii 8KCT/15 ,,	2" x 1¼	—	,, ,,
OP28	15W	Hifii 10KCT/15 ,,	2" x 1¼	—	,, ,,
		ULTRA LINEAR TYPE			
OP29	20W	6.6KCT/15 ohms	2" x 1¼	—	,, ,,
OP30	20	8.5KCT/15 ,,	2" x 1¼	—	,, ,,
OP31	20	10KCT/15 ,,	2" x 1¼	—	,, ,,

LOW POWER EXTENDED RANGE

OP32	6W	8KCT/7 ohms	1¼" x ⅞"	—	Clamp
OP33	6W	8KCT/15 ,,	1¼" x ⅞"	—	Clamp
OP34	3W	Universal	9/16 x 9/16	—	,,
OP35	6W	10KCT/15-7.5-3 ohms	¾ x ¾	—	,,
OP36					
OP37 / OP50	8W U/L / 10W stereo	9KCT/15-7.5-3 ohms	⅞" x ⅞"	—	,,

Auckland Transformer Co. Ltd.

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electrical unit, the ratios can be established in any laboratory which has the proper equipment and techniques.

Since the accuracy of the methods of comparing different values of electrical quantities is quite high, the trend these days is for companies in the electronics industry to send a few transportable reference standards of high stability to the National Bureau of Standards for calibration and then compare them to working standards using ratio techniques.

Legal Value of Units

One might note that the methods of comparing resistors to resistors, voltages to voltages, capacitors to capacitors, etc. are more accurate than the absolute values of the quantities measured are known. For instance, one can compare the values of two resistors with an accuracy of 0.1 part per million, but the absolute value of the ohm, the value derived from the fundamental quantities of length, mass, time and current is only known within a few parts per million. It is desirable to have national reference standards that are as accurate as their values can be intercompared. Therefore, the units derived and maintained by the National Bureau of Standards are defined by act of Congress to be perfect for purposes of trade and are the legal values of the units. As the NBS develops more accurate methods of deriving the absolute values of the units, they will make appropriate changes, if required, in the legal values of the national reference standards.

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LISTENING POST—continude from page 24

Transmission (1) is to North America from 0415 to 0515 GMT with news in English at 0425.

Transmission (2) is for the Thai Forces in Korea, Republic of Vietnam and Cambodia from 0930 to 1020 GMT. Languages used for this transmission are Thai, Vietnamese and Cambodian.

Transmission (3) is the General Overseas Service in English, Malay and Chinese from 1025 to 1157 GMT. English news is broadcast at 1030.

Transmission (4) consists of a relay from the Home Service between 1300 and 1400 GMT.

Transmissions (1) and (4) are broadcast on a frequency of 11910 while transmissions (1) and (3) use 6160 and 7185. The transmitter power in all cases is 50Kw.

PHILIPPINES: A good clear signal is heard from the Far East Broadcasting Company in Manila when they commence their English transmission for the day on 17810kc/s at 2200 GMT. English concludes on this frequency at 0030.

The "Pacific Hour" programme for Australia and New Zealand is broadcast between 0900 and 0945 from Mondays to Saturdays and from 0830 to 0945 on Sundays. The frequency in use for this transmission is 11850kc/s.

DENMARK: The Voice of Denmark is currently using 9520 in their transmission on Tuesdays, Thursdays and Saturdays to this area. However, reception is very poor because of the presence of VOA on the same frequency. The time of the transmission is 0900 - 1000 with English occupying the last half.

The daily broadcast to Danish ships is received a bit better from 0630 to 0700 GMT on 15165kc/s. This transmission is easily identified on opening with the interval signal of a ship's bell striking eight bells.

ENQUIRY CARD AD. 18

ENQUIRY CARD AD. 19

SILICON DIODE POWER TRANSFORMERS AVAILABLE FROM BEACON RADIO LTD.

R98 T.V. POWER TRANSFORMER

For R.T.V. & H. 1959 and later T.V. Sets.
Delivers 260v @ 300mA D.C. Full wave voltage doubler.
230:115v A.C. @ 300mA D.C.
:12.6v C.T. @ 5A (2 windings ea. 6.3 @ 5A).
:0—6.3—7.5—9 @ .6A. Picture tube winding.
Choke:—C36. Use 400v P.I.V. Diodes.

R103 Stereo Power Transformer

R.T.V. & H. Aug. 60. 7w Stereo.
230:245v @ 150mA. D.C.
:104v @ 150mA D.C. Voltage doubler Rect.
:6.3v C.T. @ 5A.
Choke:—C42. Use 400v P.I.V. Diodes.

R104 Stereo Power Transformer. 10w

320v @ 320mA. Voltage doubler Rect.
230:130v @ 320mA.
:6.3v @ 6A.
Choke:—C49. Use 500v P.I.V. Diodes.

R105 T.V. Power Transformer For Philips T.V. Kitsets

220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:6.3v @ 10A.
:0—6.3—7.5—9 Ov @ 0.3A. Picture tube Winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R106 T.V. Power Transformer for Philips T.V. Kitsets

This type similar to R105 but less Picture Tube boost taps. Main Fils. 12.6v C.T. @ 5A.
220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:12.6v C.T. @ 5A (2 windings 6.30v @ 5A each).
:6.3v @ .3A Picture tube winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R108 Small Stereo Headphone Power Transformer

250v @ 22mA D.C.
230:110v @ 22mA D.C. Voltage doubler Rect.
:6.3 @ 0.86A.
Choke:—C41. Use 400v P.I.V. Diodes.

R110 T.V. Power Transformer. For Philips T.V. Kitsets

This transformer uses full wave bridge rectifier. Requires no limiting resistor unlike equivalent voltage double types, also has advantage of no insulated capacitor and lower ripple output with smaller choke.
Output 220v @ 420mA D.C.
230:172v @ 420mA D.C. Full wave bridge Rect:
:12.6v C.T. @ 5A (2 only 6.3v winding @ 5A).
:6.3v @ .3A Picture tube winding.
Choke:—C50. Use 400v P.I.V. Diodes.

R111 T.V. Power Transformer

Similar to R110 but for R.C.A. type Kitsets.
260v @ 350mA from Rect.
230:207v @ 350mA D.C. Full wave bridge Rect.
:12.6v C.T. @ 5A (2 only 6.3v windings each 5A).
:6.3v @ 0.6A. Picture tube winding.
Choke:—C42. Use 400v P.I.V. Diodes.

R112 Oscilloscope Power Transformer

R.T.V. & H. 1963. Calibrated.
230:110v @ 80mA D.C. Full wave voltage doubler.
:6.3v @ 2.4A.
:6.3v @ 1A.
:6.3v @ 1A.
Use 400v P.I.V. Diodes.

BEACON RADIO LIMITED

Corner Brown and Fitzroy Sts., Ponsonby, Auckland. P.O. Box 2757. Telephone 16-164 (3 lines)

ELECTRONICS IN MEDICINE

Continued from page 15

1 electrode failure at 9 mths.
1 transistor failure at 9 mths.
1 subject external force

Type C — 2 units
Both satisfactory for 6 mths.

Type D — 3 units
1 rate failure at 12 mths.
1 immediate failure
1 satisfactory at 6 mths.

Type E — 1 unit
Satisfactory — fatal from other causes.

It will be seen that 20 out of 27 units have given good service and 2 failures were due to electrode faults. Electronic failures accounted for the remainder.

Cole and Yarrow thus give some indication of the in-service pattern of failure and it would seem that electrodes are the most likely source of trouble. The connection must be able to withstand about 38 million movements a year and the importance of continuing the insulated connecting wire on to form the electrode, becomes apparent. Even the spiral wound connecting wire used failed in two cases adjacent to the electrode point. Stimulation potential needs appear to fall after a short time and the initial two or three volts could be reduced to one volt after the electrodes have settled in the muscles. Nevertheless higher than one volt is used for safety's sake. The pigtail (of the Medtronic unit) mentioned above can be used for such adjustments.

Pacemakers are designed so that a failing battery increases the rate and thus can be readily detected.

It should be remembered that the pacemakers at present being used are of commercial manufacture and the failure rate at Green Lane Hospital is over a fairly small number. Microelectronics and military electronic techniques will improve the reliability but greatly increase the cost — the present pacemaker costs around £200. In America, where one maker has made over 2000 units the failure rate is much better.

The component failure rate has been .5% as has the battery failure rate and wire breakage rate has been .8%. Surprisingly, the case failure rate was nearly 3% with a Teflon case but epoxy cases should not present this trouble.

Future Pacemaker Developments

Reliability rather than exotic gadgetry is the key to future pacemaker work. Component reliability is now mainly a matter of cost as the techniques are already available. Microelectronic techniques should be feasible as the potential for pacemakers is adequate to ensure an economic market — in America there is an estimated annual number of 30,000 new cases of heart defects from Stokes-Adams seizures.

Battery failure and life is the one aspect that is still worthy of major research. Whilst battery replacement is a simple operation the psychological and physiological effects on elderly patients can cause complications in isolated instances. For this reason development of biologically derived energy is being investigated. Two possibilities are being looked at — use of internal body movements to wind up a mechanism like a watch movement that will strike a piezoelectric crystal and the direct pressure of a heart pulse to drive such a crystal.

The possibility of replacing the complicated internal pacemaker with an internal unit of simple form has also been investigated. One such uses a silicon diode to rectify an externally applied R.F. field. Another uses a buried coil, externally excited to feed pulses to the cardiac muscles. Both have the physical and technical disadvantage of needing to be accurately fixed to the body so that adequate coupling to the stimulator is obtained.

Strangely enough, most patients prefer an internal implant to a body worn pacemaker feeling that an external unit is more likely to be damaged.

Work is also being carried out on delay type pacemakers taking their pulsing from select peaks in the cardiac wave form and applying the stimulus about 120 milliseconds later to coincide with the next expected peak (remembering that each heart beat waveshape has several peaks).

(To be continued next month when radio pills and laser applications will be discussed).

The two pacemaker illustrations are by courtesy of the N.Z. Medical Journal.

SONY AND TEKTRONIX ANNOUNCE JOINT VENTURE

Sony Corporation, Tokyo, have announced a jointly-owned new company "Sony-Tektronix" to be formed in Japan with Tektronix Inc. of Oregon, U.S.A., well-known oscilloscope manufacturer.

Tektronix Inc. which has its head office and factory in Beaverton, Oregon is famous for the production of high quality oscilloscopes, auxiliary instruments, etc.

"Sony-Tektronix" will manufacture these Tektronix instruments in Japan and also use their engineering capability to develop new instruments utilising Sony's techniques and engineering of miniaturisation of various products utilising transistors and diodes.

Head office and factory of the new company is planned for Tokyo, and business will start soon after government approval.

Enquiry Card 155

* * *

NEECO REORGANISATION

Following group reorganisation, the National Electrical and Engineering Co. Ltd. has become the holding company for three subsidiaries; Neeco Wholesalers Ltd., Speedway Products Ltd. and N.Z. Insulators Ltd.

MOBILE COMMUNICATIONS

Continued from page 25

then it's either tedious plotting on graph paper or use the oscilloscope. Indeed where variable selectivity or multichannel gear has to be aligned the wobbulator method is the only one that is satisfactory. The use of the wobbulator has two further advantages. When the user is thoroughly familiar with it, it is by far the quickest method of alignment, secondly the curve presented on the scope will immediately show up any fault in the tuned circuits.

I have spent some time talking about the wobbulator because this unjustly neglected instrument can readily improve the performance of most receivers used in mobile communication.

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RIC	1	RF Interference Handbook	69/6
ERH	1	Electronic Engineers & Technicians Reference Handbook	49/6
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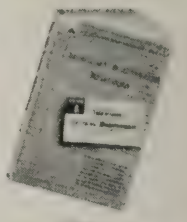
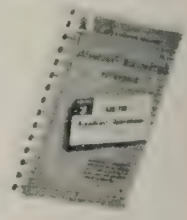
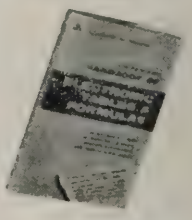

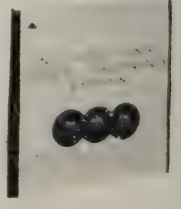

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BOOK REVIEWS

The first book for review this month is "Introduction to TV Servicing," by H. L. Swaluw and J. Van Der Woerd. Published by Philips Technical Library. Translated from German by E. Grubba. Second revised edition 1963.

The authors' stated aim has been to provide information in a manner particularly suited to the needs of any radio technician with no prior knowledge of TV. In this they have had good success. The information presented goes beyond a mere introduction. Were it indexed, the volume would be a useful reference for any TV serviceman. This feature is the only criticism of an otherwise comprehensive treatise.

The book contains fourteen chapters devoted almost entirely to the reception of television signals and receiver circuitry, in fact the only reference to the transmission side is in Chapter 7 which contains a brief reference to propagation. Rather surprisingly there is almost no reference to receiving aerials, what little information there is being included in the chapter on the channel selector (tuner).

Readers in this part of the world will probably be somewhat surprised to learn that the particular Philips receiver used throughout the text as source of the circuit diagrams and description of circuit function is a 17" model employing a 90° picture tube of "bent gun" (ion trap) construction. Yet it is stated in the preface to this edition (1963) that this is the latest model of a TV receiver". As consequence of this there is no information on wide angle (110°) scanning.

Two chapters are devoted to the nature and use of test instruments, the second of which provides many excellent diagrams and actual photographs of test patterns resulting from misalignment. There are detailed instructions for using the pattern generator, oscilloscope and wobbulator (sweep generator) and signal generator.

The final chapter containing 83 pages is devoted entirely to photographs of test patterns illustrating every conceivable condition likely to be encountered in practice from a perfect picture through various conditions of lack of synchronisation, poor linearity interference, ghosting, lack of definition.

A must for any serviceman's book shelf. —J.W.S.

The second book we have for review is entitled "Nonlinear and Parametric Phenomena in Radio Engineering", written by A. A. Khaikevich. Edited by K. A. Pullen Jr. Published by Iliffe Books.

Traditionally, problems involving non-linearity have been approached by considering equivalent linear systems and then making allowances for the non-linearity. This method is excellent for the study of networks having essentially linear characteristics, but is definitely not suitable where there is a major departure from this condition.

This book was found to present a clear, interesting introduction to the theory of non-linear systems, and in particular, its practical application to typical electronic problems. The first chapter introduces non-linear circuits, and fundamental non-linear processes, and amongst other things deals with voltage and current stabilisation, frequency multiplication, rectification, detection, and non-linear methods of amplitude modulation. The second chapter covers the generation of oscillations, various types of oscillators including those used for micro-wave techniques.

The third chapter deals with the response of non-linear systems to external signals, for example, the operation of rectifiers, regenerative receivers, and the synchronisation of oscillators. The fourth and final chapter, which discusses circuits with variable, time-dependent parameters, is of particular interest, at the present time when variable parameter devices have opened up new fields in solid state electronics.

This text could well prove a useful addition to the library of research workers or electronic engineers who are dealing with non-linear phenomena.

Our copy by courtesy of and direct from, the publishers.

COMPACT BROAD-BAND BALUN TRANSFORMERS

Continued from page 17

such poor engineering practice can produce other associated evils, such as Broadcast and Television Interference due to energy radiated from the outer shield of the feedline, which is supposed to be maintained at earth potential.

The author wishes to acknowledge gratefully information from the following references:

"Calculation of Inductance of Toroids with Rectangular Cross Section and Few Turns" by R. F. Schwartz, Proc. I.R.E. Oct. 1957, P.1416.

"Some Broadband Transformers" by C. L. Ruthroff, Proc. I.R.E. Aug. 1959, P.1337.

"Broadband Balun Transformers" by R. Turrin, Q.S.T. Aug. 1964.

"The Design of H.F. Baluns for High Powers" by J. Wood, M.I.E.E.E. Electronic Engineering March, 1965.

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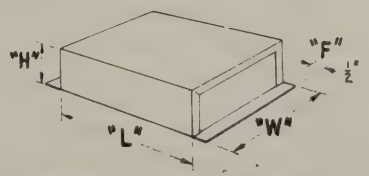

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INCREASING RELIABILITY OF ELECTRONIC EQUIPMENT

By J. Stubbs Walker

The London exhibition of radio and electronic components in May contained many examples of the latest techniques in micro-electronics

The development of electronics itself is largely dependent on the tempo of technical headway by the makers of electronic components. Component development is a continuous and many-pronged activity. Modern "run-of-the-mill" electronic equipment calls for standards of precision and reliability that were unknown, even in the laboratory, ten or fifteen years ago. With the increasing complexity of apparatus in daily use miniaturisation becomes more essential if the controlling equipment is not to exceed in size the machinery it governs. If the electronic systems in a modern airliner had to be built of components available 20 years ago, the aircraft could scarcely take off!

Guarding Against Failure

The wider the application of electronic systems, the more essential it becomes to guard against failure, and this is reflected in the preoccupation of the component manufacturers with achieving as close an approach as possible to absolute reliability. After all, the breakdown of a television transmitter could annoy a few million people but the failure of the safety circuits of a nuclear establishment could mean disaster.

According to the Radio and Electronic Components Manufacturers' Federation, Britain's electronic component industry, currently producing goods worth about £160,000,000 a year, of which more than one-third is exported, has maintained a rate of progress that has enabled it to increase its hold on world markets. This year, the industry presented its biggest and most comprehensive exhibition, the Radio and Electronic Components Show at Olympia, London (May 18 to 21). The organiser (1) states that there were more than 300 exhibitors at the show.

Mr. A. F. Bulgin, president of the R.E.C.M.F., has announced that the exhibition was 20 per cent larger than the previous one, in 1963, which attracted a record attendance — 50,000 visitors, including 2500 from overseas.

Reliability Test

The technical developments shown at Olympia were largely concerned with micro-electronics and increased reliability. One company (2) is now carrying out a reliability study, in association with Britain's Ministry of Aviation, which will eventually amass 750,000,000 hours of testing thin-film components, used in micro-electronic assemblies. A first, interim report on the tests, covering the equivalent of 33,500,000 hours (more than 3500 years), shows that, so far, there has not been one failure. The calculation of failure rates is complicated, but the initial results indicate that, again so far, at 90 per cent confidence, 0.008 failures can be expected every 1000 hours.

It is not difficult to appreciate the necessity for increased component reliability when it is remembered that a new air traffic control centre near London will incorporate some 40,000,000 components, including 3,000,000 transistors.

Contribution of Semiconductors

Semiconductors have undoubtedly made a considerable contribution to the general reliability of electronic equipment, just as they have given the lead in miniaturisation. An example of their present degree of reliability is given by the world's first transistorised submarine cable, recently put into service between Britain and Belgium. The repeaters — amplifiers which make up for cable losses — incorporated in the cable require a life-expectancy of at least 20 years to be commercially acceptable.

The inherent robustness of semiconductor devices is not the only factor of reliability. Because they are economical in power requirements, other components associated with them operate under much less stress than when thermionic valves are used.

Modern techniques have enabled complete circuit assemblies to be formed without the need to use individual components. Capacitors, resistors and semiconductors can be deposited, under vacuum, on wafer-thin substrates. This method, and others, of manufacturing "solid" circuits has proved extremely reliable while, at the same time, it is possible to achieve very high component densities. Part of the telemetry electronics of the European Launcher Development Organisation (ELDO) space vehicle contains the equivalent of 1320 resistors and capacitors and 485 semiconductors in a space little greater than a miniature, domestic transistor set. This represents a packing density of 350,000 components to the cubic foot.

Reversible Counter Unit

Another example of micro-electronics is a reversible counter unit (3), in which 100 solid-state networks are assembled in a volume of 15 cubic inches, yet with full provision for maintenance, accessibility and air cooling. If built in conventional form, this equipment would require some 2500 components and would occupy at least ten times the volume. Other assemblies from the same manufacturer include a 45 megacycles-per-second intermediate-frequency amplifier in which the coupled tuned circuits have been deposited on the sub-

strate in the form of helical "windings", and a wide-band amplifier with 200 megacycles-per-second band-width and ten decibels gain per stage.

One of the world's most famous radio manufacturers (4) has recently anounced the formation of a micro-electronics division to exploit new techniques that have been developed in its research laboratories and have already been applied successfully to computers and aircraft electronics. The Myriad computer, based on integrated circuit modules, attracted considerable attention when it was introduced a few months ago. The new division will make integrated circuit elements available commercially and will provide a design advisory service.

Versatile Transistor

The transistor is generally looked on as the component which is replacing the thermionic valve. It is, however, much more versatile than that. A transistorised high-speed switch has now been produced to replace the conventional electro-mechanical relays used in telecommunications equipment, with the advantage that it requires no setting up or adjustment throughout its life. The new switches have already been ordered by the Ministry of Aviation as plug-in replacements for mechanical telegraph relays.

Because there are no moving contacts, problems of sparking and corrosion do not arise. The switch is unaffected by severe humidity, and temperature variations from minus 10 degrees Centigrade to 70 degrees Centigrade produce no significant effect on performance.

Testing of Solid-State Elements

The new techniques have necessitated the design of advanced instruments and apparatus for the manufacture and testing of solid-state elements, and the Olympia show made quite a substantial feature of progress in this field. An example is a new, double microscope for the alignment of small photographic masks used in the process of producing silicon planar transistors and micro-circuits. (5) A conventional microscope allows only one point of the mask to be aligned, but the new instrument allows the simultaneous alignment of two widely separated points on the mask. The two fields of view can be seen by the operator either alternatively or simultaneously by using a foot switch.

During the exhibition, the Institution of Electrical Engineers (6) held a conference in London to discuss recent developments in active and passive components, including integrated circuits, and in the materials of which they are made.

(1) Industrial Exhibitions Ltd.
(2) Mullard Ltd.
(3) E.M.I. Electronics Ltd.
(4) The Marconi Company Ltd.
(5) W. Watson and Sons.
(6) The Institution of Electrical Engineers.

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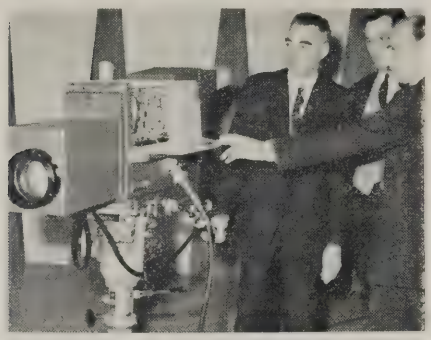
Ten years of Marconi experience of 4½in. image orthicon cameras is built into the Mark V, being examined here by Mr. L. Martin of the N.Z. Broadcasting Corporation. Fully transistorised it is claimed to be simple to operate as an ordinary photographic camera and equally as stable and reliable.

There are more Mark IV's in use



throughout the world than all other makes added together. A total of 23 Marconi Mark IV cameras, supplied by A.W.A., are in service in New Zealand.

Personalities are, left to right: Mr. Martin, Mr. N. Parker-Smith and Mr. P. Turrall of Marconi.

Enquiry Card 144.

HIGH STABILITY H.F. RECEIVER

A high stability, general purpose, H.F. Receiver, Type H2301, covering the frequency band 500 kc/s to 30.5 Mc/s is now available from the Marconi Company. This compact receiver is suitable for reception of a.m., c.w. and s.s.b. signals, and with the addition of a special f.s.k. adaptor, Type H5011, can be used with single channel teleprinter circuits.

The frequency range is covered in thirty steps of 1 Mc/s with an overlap of 100 kc/s and the calibration accuracy is within 1 kc/s. Dial calibration is linear and presented so that the frequency is given by combining readings on separate "Mc/s" and "kc/s" scales. Calibration can be checked at any time with a built-in kc/s crystal oscillator.

High selectivity is achieved by a double conversion technique, employed with crystal control of the first local oscillator to give an exceptionally high stability for this class of receiver.

The receiver incorporates a built-in loud speaker and separate audio outputs are available with independent gain controls. The f.s.k. adaptor is fully transistorised and caters for shifts of from 200-850 c/s, at telegraph speeds of up to 100 bands.

Enquiry Card 138.

N.Z. AIR FORCE EQUIPMENT

An order in excess of £100,000 has been received by the British firm, Burndept Electronics Ltd., of Erith, Kent (a member of the Royston group of companies) for the initial re-equipping of the Royal Navy, the Army Air Corps and the Royal New Zealand Air Force, with fully-transistorised Saber distress signal beacons.

This order covers the initial stage of the re-equipping programme and will be followed by further orders to meet full requirements.

These orders follow behind the recent R.A.F. contract for over £350,000 of Saber equipment which means that all the U.K. armed services have now standardised their search and rescue equipment.

* * *

SUBMINIATURE 1 A DIODE

A subminiature industrial diode rated at 1 A, at 50°C ambient, with a 50 A 10 msec surge rating has been introduced by the International Rectifier Co. (Great Britain). The new series is designated 10D1 to 10D10, with p.i.v. ratings from 100 to 1,000 V.

Features of the diodes are small physical size, robust moulded construction, high surge capacity and ability to withstand high peak transient reverse voltages. They are designed for industrial and domestic applications where small size and efficiency are important.

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MAY, 1965

TRANSISTOR TEST JIG

The Transistor Test Jig, Type 1351-OA, is designed to provide a convenient means for measuring the Y parameters of transistors on the RX Meter, Type 250A, over the frequency range from 500 kc to 250 mc. The jig consists of four basic components: a mounting adapter and three separate plug-in test circuits for measuring Y_{11b}, Y_{11e}, and Y_{22e}.

The mounting adapter mounts conveniently on the RX Meter and includes bias feed and bypassing for an external power supply (—hp— 721—A). Each of the test circuits is constructed on a printed circuit board for maximum stability and repeatability. Residual reactances have been held to a minimum, providing measurement accuracy.

Enquiry Card 140.

* * *

PORTABLE DIGITAL DRAW-SPEED INDICATOR

The portable digital draw-speed indicator from the Westinghouse Relay-Instrument Division can conveniently measure machine speed differentials in plants that use rotating equipment and can handle up to six machine sections. It is normally used in conjunction with hand tachometers having a twelve-in. circumference wheel.

The portable unit incorporates a decimal matrix that enables the operator to set the roll-to-tachometer conversion number directly, without any preliminary binary calculations. Readings are displayed directly in f.p.m. or draw-speed (differential) as selected.

Removed from its portable housing, the unit, which measures 24in. by 9½in. by 15in., can be mounted in a 19in. relay rack. It is five-rack units high, and weighs 47lbs. The unit has a supply voltage of 120 volts, 50/60 cycles and a power consumption of 250 watts. It operates in temperatures from 20 degrees F. to 115 degrees Fahrenheit. Both resolution and error are one fpm.

A banking switch is provided to de-energize the readout during the counting cycles. There is a telephone jack on the chassis to connect with the plug on the hand-tachometer cable.

Enquiry Card 141.

* * *

SOLID STATE CONTROLS FOR COOKERS

What is believed to be the first application of solid state controls in domestic cookers has been shown in Britain by Smiths Clock & Watch Division. A prototype cooker incorporating the control systems has already been submitted to the electricity industry's Testing and Development Laboratory and all electric cooker manufacturers in Britain are being sent prototypes of this S3 control system.

Solid state controls with no moving parts are considered to be more reliable than present electro-mechanical systems. Accuracy of temperature control to ± 1° C. at 250° C. is claimed for the "S3" system. The advantage of flexibility derives from the compact nature of the system in which component parts —hot plate, grill and oven controls— are arranged in a series of replaceable modules.

Essentially the S3 system comprises a 12 V power pack, relay board, control panel and interlinking electrical electronic circuitry, which can be installed in available space at the base of the cooker. Because all connections are electrical, using a single multi-core cable with no thermostat capillary tube connections, the control panel can also be sited away from the cooker. This would enable designers to extend the development of built-in cooker systems.

The control panel contains a "pan-sense" regulator for one hot plate, three non-linear hot plate regulators, linear regulator for the grill, meat probe and oven thermostat components and a programming clock. Each control module can be separately withdrawn and replaced, making on-the-spot servicing practicable even where maintenance staff have no electronics knowledge.

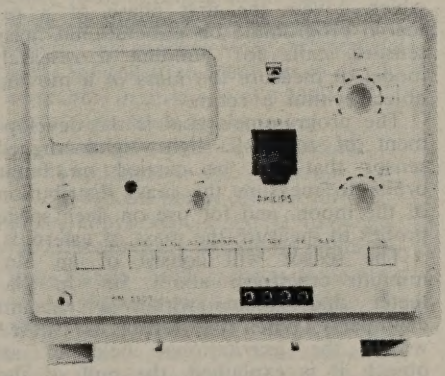
Enquiry Card 147.

* * *

TRANSISTOR ANALYSER

The PM 6503 transistor analyser is intended for laboratory, factory and workshop use in accurately checking the following parameters of p-n-p semiconductors, including diodes: short circuit, forward and leakage currents and static current gain. Static curves can also be plotted.

Two stabilised power supply units provide continuously variable voltages and currents, the values of which can be read directly from the moving-coil meter. Power supplies are protected against short-circuit by a circuit breaker.



The parameter to be measured and the measuring range are selected by a series of push buttons, which allow many combinations in almost any desired sequence. Different values of resistance can be switched in parallel with the base-emitter junction.

In this way the condition of measurement can be adjusted to the circuit in which the transistor is used and far more meaningful results obtained. A special socket for quick connection and release of transistors with long connection wires and a special adapter for the other most common types of transistors raise the usefulness of the instrument.

Enquiry Card 153.

TELEMETER TRANSMITTER

A Teleductor transducer that is reliable, safe, economical and accurate to within 1 per cent is available for current and potential measurements. The compact unit from the Westinghouse Relay-Instrument Division, weighs one pound and is available in two forms—one measures alternating current, the other voltage, by converting them to a proportional d-c milliampere value. Output for both units is 0.3-milliampere d-c into any load up to 15,000 ohms. This d-c output is linearly proportional to the current or voltage input. The transducer has an input of 0 to 5 amperes (60 cps) and the voltage transducer has an input of 0 to 150 volts (60 cps). Transducers for other ranges can be obtained.

The unit can be used as a simple telemeter transmitter for applications where the interconnecting channel is a d-c circuit. It is suited for use with Westinghouse supervisory control systems and also serves as a general purpose transducer to operate recorders, controllers, and telemeter transmitters. Its load capability allows long line-wire operating circuits so it is useful in applications where ammeters or voltmeters are located at a distance from the current or potential transformers. With ammeter circuits the unit can be open circuited without high voltage (45 maximum. It has practically instantaneous response.

The transducer consists of a two-winding torodial transformer having iron with specially selected characteristics, a full-wave silicon rectifier with selected Zener characteristics, and loading and calibrating resistors. A calibrating adjustment provides easy adjusting of the exact millivolt level desired. A small resistor connected across the output terminals changes the d-c milliamperes to millivolts.

Enquiry Card 143.

* * *

LIGHT REPLACES BRUSHES IN NEW D.C. MOTOR

The U.S. Boeing Company has developed an unusual type of d.c. motor, called a "Photo Motor."

A d.c. motor operating in a vacuum soon burns itself out, because of arcing about the commutator. The "Photo Motor" uses light in place of brushes. Instead of the usual rotating armature, the core of the motor remains stationary. The outside turns.

Photoelectric cells are used as switches and operate through a shutter fixed to the rotating case. This shutter is a blank disc of metal with a slot cut into it, such that as the case turns the slot passes each photoelectric cell. Light strikes the cell and turns on the power. Very little light is said to be needed to cause this switching action.

The two prototypes assembled so far have relatively high efficiencies. They are self starting and may be controlled precisely from zero to full speed.

Enquiry Card 150.

SEMICONDUCTORS FOR THE MOTORIST

Lucas equipment for road vehicles shows signs of more and more progress towards all-transistor systems each year. The Opus Ignition (oscillating pick-up system), which has already had many successes in Formula II racing cars is now being developed for standard production cars. A magnetic pulse, generated by the pick-up, which is mounted in the distributor, triggers an amplifier, which in turn provides an h.t. impulse to the appropriate sparking plug at the right moment. As there is no contact breaker, this system is an advance over conventional ignition in that maintenance is reduced to an absolute minimum. T.A.C. Ignition (Transistor-Assisted Contacts)—introduced some time ago—reduces contact wear, while the Lucas fully electronic ignition system is obviously the next stage in the modernisation of standard production cars.

The Lucas automatic anti-dazzle mirror is another example of innovation —a photoelectric cell senses increased illumination from a following vehicle's main beam headlights and automatically deflects the mirror to its anti-dazzle position.

The use of an alternator has the great advantage of providing a useful charge at engine idling speeds. Lucas have designed the associated control unit using transistors, producing a unit having no moving parts to require servicing.

Perhaps the ultimate in luxury and sophistication is the Lucas automatic parking light control which, through the use of a photoelectric cell, switches the vehicle parking lights on at dusk and off at dawn without the driver returning to his vehicle.

Enquiry Card 145

* * *

TELEMETERING EQUIPMENT

A telemeter is available from the Westinghouse Relay-Instrument Division, to telemeter any quantity which can be converted by a transducer to a proportional d-c voltage. It is applicable for general purpose analog telemetering on electric utility systems, pipelines, and in industrial plants.

The completely transistorised unit consists of transmitter and receiver. The transmitter converts the d-c signal voltage to a proportional frequency (15 to 35 cycles) which can then be transmitted over any common channel. A plug-in resistor card also enables transmitter operation at other frequency ranges. The receiver converts the signal to d-c current or voltage for operating conventional indicating instruments, recorders or control devices. It provides an alarm when the signal level drops below the prescribed minimum.

Over-all accuracy of the combined unit is plus or minus one per cent. Speed response to a 95 per cent scale change takes just one second. Supply voltage is 117 volts (± 10 per cent) at 60 cycles.

Enquiry Card 142.

220 CIRCUITS VIA ONE VF TELEGRAPH CHANNEL

Electronic remote control and indication equipment has been developed by a British firm to enable up to 220 circuits of digital information to be transmitted over a single voice frequency telegraph channel. The new system, which uses solid state components throughout, provides circuits over which equipment at remote locations can be operated or monitored from a central control point. Designed to operate over commercial speech circuits whether on open wires, underground cable, carrier transmission system or radio links, the system can be extended in multiples of 10 circuits to a maximum of 220. Greater circuit capacity can be achieved by combining up to 24 basic systems using voice frequency telegraph equipment to channel information over the same speech circuit. Typical applications include controlling and monitoring the operation of power stations and sub-stations, remote telemetering of analogue quantities, supervisory control of radio and television links, supervisory control of liquid and gas pipe-line operations, and high speed links for computers and data collection systems.

ENQUIRY CARD 135

* * *

NASA CONTRACT

To Build Mass Sensor for Space Use

A contract to develop a device that will sense the mass of an object at a distance by detecting its gravitational field has been awarded to the Hughes Research Laboratories by the National Eeronautics and Space Administration of America.

The £65,000 16-month contract, which covers the first phase of a research programme on gravitational mass sensors, calls for building a research model to measure the mass of a moving object within a room.

The programme's goal is the development of a small, lightweight, rugged sensor that can be carried on lunar orbits to measure the mass distribution of the moon, and for use on deep space probes to measure the mass of asteroids.

The sensor will consist of an aluminium cruciform about 5in. in diameter that rotates within a vacuum chamber. When the sensor is rotated within the gravitational field of an object, it is explained, the pull of the object on the ends of the cruciform varies with the change in position caused by the rotation. This sets up vibrational modes in the sensor that can be read out by highly sensitive piezoelectric strain transducers and measured in terms of the object's mass.

The force of gravitational attraction is very weak and the sensor will be acted upon by a great deal of "noise"—electrical, mechanical, thermal, and electronic. The Hughes approach will use the "chopping" effect of the rotation to convert the normally d.c. gravitational force to an a.c. signal, which is more easily amplified.

Enquiry Card 151.

VIDEO TAPE RECORDER

The Sony Videocorder 2000 is claimed to be the first video tape recorder designed for home use which utilises the magnetic recording principles with low tape speed movements, proven in professional television recorders. It uses a ½in. tape, moving 7½ ins. per second, eliminating tape breakages which occur at high tape speeds. There is no developing process and recorded pictures can be clearly played back immediately and repeatedly.

Sony tuner-monitor sets of different sizes are available for connection to the Videocorder in taping television pictures and viewing recorded programmes. Several videocorder models are to be available, including a console type having television receiver with clock control to record programmes in the owner's absence.

Present magnetic video tape recording and playback facilities for television broadcasting stations cost U.S. $55,000 and for industrial use, about $7,000 but the videocorder costs less than $550. Operating at one quarter the speed of similar equipment used for television broadcasting it requires much less tape but can operate continuously for 63 minutes.

Dimensions are 14¼ x 13 x 7⅞ ins. and weight, 33 lb. The recorder is easily portable. It operates on 100v or 118v AC and power consumption is 60 watts.

Enquiry Card 155

* * *

PRINTED CIRCUIT HEAT SINKS

Two heat sinks, designed for quick assembly into printed circuit boards, have been introduced by Jermyn Industries. Made of aluminium the heat sink consists of two parts which screw together on to the weld flange of the transistor and heat is radiated through fins on the outside of the heat sink.

Type 2211 (thermal resistance 38° C/W) fits T05 transistors and type 2220 (thermal resistance 37°C/W) fits T018. No fixing is required, the complete assembly solders direct into the printed circuit board.

Enquiry Card 149.

Printed for the publishers, The Magazine Press Ltd., Employers Association Bldgs., 157 Khyber Pass, Auckland, C.3. Farrell Printing Ltd., 69 Carr Rd., Mt. Roskill, Auckland.

ENQUIRY CARD AD. 22

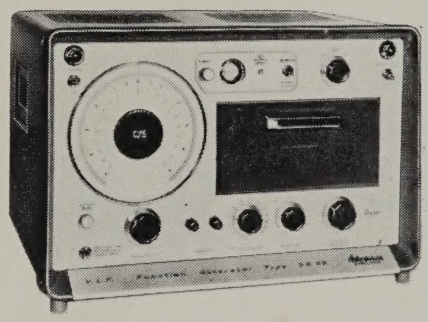
Advance

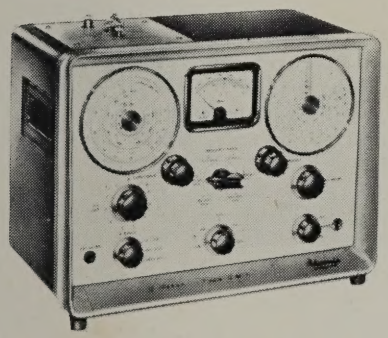
v.l.f. function generator & Q meters

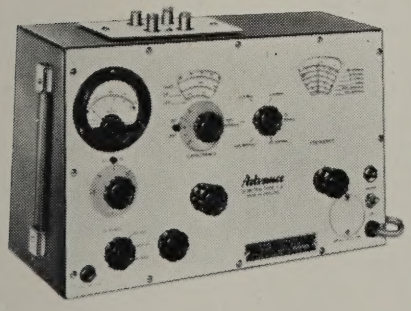
SG88

V.L.F. Function Generator

Frequency range 0·005c/s to 50c/s for single cycle disc. Higher frequency is possible by use of 2, 3 or 4, etc., cycle disc. *Calibration* ±1% full scale. *Output* VOLTAGE Continuously variable from 200μV to 22V pk.pk. AMPLITUDE VARIATION Within 1dB over entire frequency range. IMPEDANCE At maximum output 6kΩ, mid setting 16kΩ, depending on frequency. WAVEFORMS Any single valued repetitive function. *Facilities* Direction of rotation of the waveform disc can be reversed, thus reversing the time sequence of the waveform. Automatic frequency sweep device on the 0·5 to 5c/s and 5 to 50c/s bands. Sweep time is approximately 2 minutes for any 10:1 frequency excursion. Four waveform discs (sine, square, sawtooth and white noise) and one blank disc supplied. Special discs made to order. *Power requirements* 105 to 125V, 190 to 250V, 50 to 60c/s, 165W. *Dimensions* 19¾in (50cm) wide × 13in (33cm) high × 15in (38cm) deep. *Weight* 80lb (36kg).







CM1

'Q' Meter

'Q' range 15 to 600 in two bands. *Oscillator frequency* 100kc/s to 100Mc/s in six bands. *Frequency accuracy* ±1%. Stabilised signal level. *Main capacitors* Capacitor scales 10 to 70pF (±1pF), 40 to 600pF (±2%). Reactance (Xf) scales 16000 to 2200Ω–Mc/s; 4000 to 300Ω–Mc/s. Inductance (Lf²) scales 2500 to 350μH–Mc/s²; 600 to 50μH–Mc/s². *Incremental capacitor* ±5pF (on 40 to 600pF range of main capacitor) in divisions of 0·2pF. *Accuracy of inductance measurement* ±(5% + residual inductance of 0·035μH). *'Q' range* 15 to 150, 60 to 600. *Accuracy* ±(5% + 5% F.S.D.) below 50Mc/s. For frequencies above 50Mc/s and 'Q' readings above 400 the tolerance should be doubled.

'% Q' scale Range ±10% (relative to nominal 'Q' reading). *Power requirements* 105 to 125V, 195 to 225V, 225 to 260V, 50c/s (models to suit other frequencies can be supplied). *Dimensions* 18in (46cm) wide × 14in (35·5cm) high × 9½in (24cm) deep. *Weight* 38lb (17kg).

T2

'Q' Meter

'Q' range 10 to 400 in two bands. *Accuracy* ±(5% + 5% F.S.D.) below 50Mc/s. *Oscillator frequency* 100kc/s to 100Mc/s in six bands. *Accuracy* ±1%. *Main capacitors* Capacitor scale 40 to 550pF (±2%). Reactance (Xf) scale 4000 to 300Ω–Mc/s (±2%) Inductance (Lf²) scale 600 to 50μH–Mc/s² (±2%). *Incremental capacitor* 2·5pF. *Accuracy of inductance measurement* ±(5% + residual inductance of 0·03μH). *'% Q' scale* Range 10% (relative to normal 'Q' reading). *Accuracy* ±1% (i.e. ±1 division up to 50Mc/s). *Power requirements* *110 to 120V, 200 to 210V, 220 to 230V, 240 to 250V, 40 to 60c/s, 20W. *Dimensions* 15½in (39cm) wide × 10¼in (26cm) high × 6½in (16·5cm) deep.

Weight 14lb (6·5kg).

**Special model available T2E 110 to 125V, 130 to 140V, 160V, 220V, 40 to 60c/s.*

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FROM THE COMPREHENSIVE RANGE OF Advance **INSTRUMENTS AND EQUIPMENT**

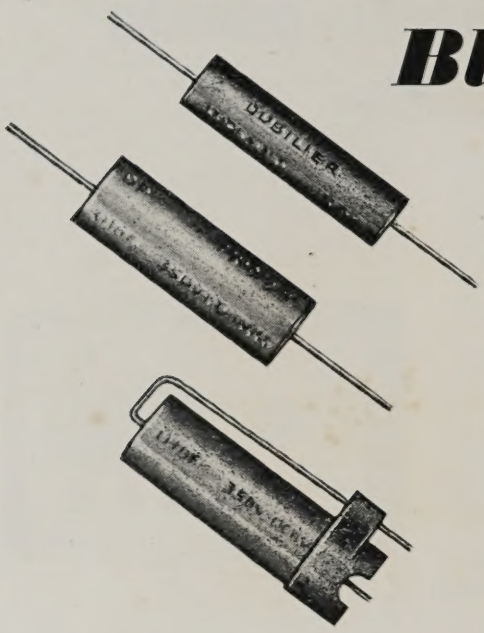
ENQUIRY CARD AD. 23

DUBILIER

Bluecon Capacitors

TYPE 660

TUBULAR PAPER DIELECTRIC



For many years, capacitor designers have sought a paper dielectric tubular construction which was simple, robust and electrically reliable. Some capacitors with expensive and heavy metal tubes and seals, have these desirable features, but the Dubilier 660 BLUECON is the most practical and simple solution so far found. The 660 BLUECON consists of an extended electrode paper dielectric capacitor impregnated in synthetic resin and an injection moulded enclosure. These components in combination represent a major technical achievement which gives the user the following advantages:

Catalogue Ref.	Cap. μF	VOLTAGE RATINGS d.c. Wkg. at 85°C.	d.c. Test at 20°C.	a.c. Wkg. r.m.s. at 50 c/s 85°C.
18705	0·02	350	1000	—
17898	0·025	,,	,,	—
18706	0·03	,,	,,	—
17899	0·05	,,	,,	—
17902	0·1	,,	,,	—
17900	0·05	500	1500	300
17903	0·1	,,	,,	300
18707	0·01	750	2250	300
17896	0·02	,,	,,	300
17901	0·05	,,	,,	300
17894	0·005	1000	2500	300
17895	0·01	,,	,,	300
17897	0·02	,,	,,	300

For Vertical Mounting moulded plastic caps are available for $\frac{3}{8}$" and $\frac{1}{2}$" diameter capacitors.

1. Freedom from materials which will seep or drip under operating conditions. (Note: complete freedom of sticky waxes and oils).
2. The all-solid construction ensures ability to sustain the most severe acceleration, vibration and mechanical shock.
3. Directly soldered joints to the extended aluminium electrodes eliminates troublesome tab connections.
4. Truly non-inductive extended foil construction gives the lowest possible self inductance and series resistance.
5. There is no exposed metal other than the wire terminations.
6. Solder coated terminations for ease of soldering.
7. Tough plastics housing will not crack or break in service and provides a clean and non-sticky finish.
8. No derating of voltage over the whole temperature range.
9. Minimum size and weight consistent with reliable performance.
10. Greatly improved shelf life and humidity resistance.

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